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VOLUME 2

GENERAL APPENDIXES

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MID-AMERICA PORTS STUDY

VOLUME 2
GENERAL APPENDICES

U.S. DEPARTMENT OF COMMERCE

MID-AMERICA PORTS STUDY

FINAL REPORT

JUNE 1979

TAMS
TIPPETTS-ABBETT-McCARTHY-STRATTON
TEMPLE, BARKER & SLOANE, INC.
CHASE ECONOMETRIC ASSOC., INC.
THE INSTITUTE OF PUBLIC ADMINISTRATION

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MID-AMERICA PORTS STUDY
VOLUME 2 - APPENDICES A - F

This volume contains 6 of 11 appendices to the main report (Volume 1) of the Mid-America Ports Study. The remaining appendices are bound in 17 separate volumes, each volume containing those portions of the appendices pertaining to one of the 17 states which participated in the study.

Appendix A - Commodity Group Analysis (TBS)
Appendix B - Port Facilities Inventory Form (MarAd)
Appendix C - Inland Waterway Fleet Technology (TBS)
Appendix D - Econometric Forecasts (CEAI)
Appendix E - Commodity Forecast Methodology (TBS)
Appendix F - Interstate Compacts in Mid-America and Procedures Governing Civil Works Projects

U.S. DEPARTMENT OF COMMERCE, MARITIME ADMINISTRATION (MarAd)
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CHASE ECONOMETRIC ASSOCIATES, INC. (CEAI)
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MAY 1979

MID-AMERICA PORTS STUDY

APPENDIX A

COMMODITY GROUP ANALYSIS

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I. INTRODUCTION TO THE COMMODITY GROUPS

Statistics on inland waterway cargo movements are collected and maintained by the U.S. Army Corps of Engineers. All cargos are classified by the Corps into one of 172 Commodity Classifications for Shipping Statistics (CCSS) which in turn comprise 41 commodity groups. These commodity groups parallel the Standard Industrial Classification (SIC) coding system. Many of the 41 resultant commodity groups represent a very small fraction of the total tonnage moved on the inland waterways.

The 171 commodities have been regrouped into 20 commodity groups to achieve the objective of utilizing a smaller, more manageable number of groups, with each group representing a more significant portion of the total movements. The 20 commodity groups are used consistently throughout the study region even though no movements of some groups occurred in certain areas.

II. COMMODITY GROUPING METHODOLOGY

The objective of formulating commodity groups was to limit the forecasting process to meaningful commodity groups which would be large enough in volume to be significant, yet internally consistent in handling characteristics.

To achieve this objective the criteria used in formulating the commodity groups were each individual commodity's cargo handling characterisitcs and that commodity's relationship to a specific industry or other economic variable. The commonality of cargo handling characteristics within a group enables that group to be matched with a specific type of cargo handling terminal.

The second criterion of associating a commodity with a specific industry, usually its major consumer or producer, or other economic variable was used to facilitate the forecasting process.

The two criteria used in formulating the groups did not always compliment each other. In some cases certain trade-offs were required between a commodity's fit with the group in physical handling aspects and its relationship to the primary economic variable that would be used to forecast the entire group.

Salt (CCSS 1491) is an example of such a trade-off between handling characteristics and forecasting considerations. Without considering handling characteristics, salt would have

been grouped with the Industrial Chemicals group, its principal user industry. However, the other commodities in the industrial chemicals group are primarily moved in liquid form whereas salt is moved in dry bulk form and has substantially different handling requirements. As a result, salt was grouped with Mining Products where its production and movements can be forecast using growth in the mining sector as the independent variable.

Certain commodities moved on the inland waterways of the study area in small volumes or not at all. This rendered their grouping less significant than that of other commodities; however, every effort was made to avoid miscellaneous assignments to preserve internal consistency of each group's handling requirements and forecasting variables.

The exhibits within this Appendix showing movements by state include substantial double counting. This was necessary due to the fact that shipments out of one state most often terminate in another Mid-America state as a receipt. This results in the total of the inbound and outbound figures being substantially greater than the actual tons shipped. The intrastate tonnages, however, represent actual tons moved as they were not double counted. The last point that should be made about the set of exhibits is that not all shipments originate or terminate within the study region; therefore such shipments were not double counted. The net flow of a commodity group into or out of the study region can be determined by comparing the regions total inbound and outbound shipments.

Each commodity group chapter includes three standard exhibits in addition to various other exhibits which show information pertaining to the production and consumption of specific

commodities. The standard exhibits show the percentage breakdown of each commodity group; the shipments, receipts and intrastate movements for each group; and the aggregate shipment receipts and intrastate movements within the study region for the period 1969-1976.

The commodity group breakdowns by tons and percent were determined by using the U.S. Army Corps of Engineers statistics for consolidated movements on the Mississippi River System. From the statistics, the percentage breakdown of the group was determined. These percentages were then applied to the total tons of the relevant commodity group moved in the Mid-America Region to determine the number of tons of each individual commodity moved in the region. It should be noted that the total of the tons in these exhibits represent actual tons moved in 1976, whereas the other exhibits double count cargo both shipped and received in intrastate movement.

The last common exhibit in each commodity group chapter presents the aggregate inbound, outbound and intrastate tonnages as discussed in the previous paragraph for a period of eight years, 1969-1976. This time series of aggregate movements provides an understanding of the growth or decline in shipments but should not be construed as the absolute changes in actual tons for the reasons enumerated above.

Exhibit II-1 present the 20 Mid-America Commodity Groups and the actual tons moved (interstate outbound and intrastate) in 1976. These twenty commodities varied in shares of total river traffic from Coal (29.7 percent) to Bauxite and Aluminum Ores (.1 percent). Exhibit II-2 presents the composition of

each of the 20 Commodity Groups, listing in each case the CCSS codes within each. Exhibit II-3 lists the terminal codes that describe cargo handling requirements.

Exhibit II-1

MID-AMERICA PORTS STUDY

COMMODITY GROUP TONS MOVED IN 1976

	Commodity Group	Tons (in thousands)	Percent of Total
1.	Cash Grains	44,318	10.0
2.	Iron and Nonferrous Metal Ores	12,363	2.8
3.	Bauxite and Aluminum Ores	420	.1
4.	Coal and Coal Products	131,359	29.7
5.	Crude Petroleum	33,811	7.6
6.	Petroleum Products	87,452	19.7
7.	Industrial Chemicals	25,673	5.8
8.	Agricultural Chemicals/ Fertilizers	13,175	3.0
9.	Milled Grains and Agricultural Products, NEC	7,384	1.7
10.	Lumber and Wool Products	1,797	.4
11.	Sugar and Molasses	1,240	.3
12.	Primary Ferrous & Nonferrous Metal Products	6,339	1.4
13.	Fabricated Metal Products	535	.1
14.	Scrap Metals	1,558	.4
15.	Construction Materials	42,741	9.6
16.	Mining Products, NEC	15,711	3.5
17.	Non-Durable Manufactures	2,214	.5
18.	Durable Manufactures	2,842	.6
19.	Waste and Scrap	5,308	1.2
20.	Waterway Improvement Materials	7,337	1.6
	Total	443,585	100.0

Exhibit II-2

MID-AMERICA PORTS STUDY
COMMODITY GROUP COMPOSITION

Group 1--Cash Grains (Terminal Code O)

0102	Barley and Rye
0103	Corn
0104	Oats
0105	Rice
0106	Sorghums
0107	Wheat
0109	Grains, NEC
0111	Soybeans
0112	Flax Seed
0119	Oilseeds, NEC

Group 2--Iron and Nonferrous Metal Ores and Concentrates (Terminal Code F)

1011	Iron Ore and Concentrates
1021	Copper Ore and Concentrates
1061	Manganese Metal Ores and Concentrates
1081	Chrome Ore and Concentrates
1091	Nonferrous Metal Ores, NEC

Group 3--Bauxite and Aluminum Ores (Terminal Code Q)

1051	Bauxite and Other Aluminum Ores and Concentrates

Group 4--Coal and Coal Products (Terminal Code E)

1111	Anthracite Coal
1121	Coal and Lignite
2920	Coke, including Petroleum Coke
3313	Coke (Coal and Petroleum), Petroleum Pitches and Asphalts, and Naphtha and Solvents

Group 5--Crude Petroleum (Terminal Code J)

1311	Crude Petroleum

Group 6--Petroleum Products/Lubricants (Terminal Code K)

2911	Gasoline
2912	Jet Fuel
2913	Kerosene
2914	Distillate Fuel Oil
2915	Residual Fuel Oil
2916	Lubricating Oils and Greases
2917	Naphtha, Mineral Spirits, Solvents, NEC
2918	Asphalt, Tar and Pitches
2921	Liquified Petroleum Gases, Coal Gases, Natural Gas, and Natural Gas Liquids
2991	Petroleum and Coal Products, NEC

Group 7--Industrial Chemicals (Terminal Code R)

2810	Sodium Hydroxide (Caustic Soda)
2811	Crude Products from Coal Tar, Petroleum, and Natural Gas, except Benzene and Toluene
2812	Dyes, Organic Pigments, Dyeing and Tanning Materials
2813	Alcohols
2814	Sulphuric Acid
2815	Boric Acid
2816	Radioactive and Associated Materials, including Waste
2817	Benzene and Toluene, Crude and Commercially Pure
2818	Sulfuric Acid
2819	Basic Chemicals and Basic Chemical Products, NEC
2821	Plastic Materials, Regenerated Cellulose and Synthetic Resins, including Film, Sheeting and Laminates
2823	Synthetic (man-made) Fiber
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
2861	Gum and Wood Chemicals
2891	Miscellaneous Chemical Products
1493	Sulfur, Liquid

Group 8--Agricultural Chemicals/Fertilizers (Terminal Code I)

1471	Phosphate Rock
1479	Natural Fertilizer Materials, NEC
2871	Nitrogenous Chemical Fertilizers, except mixtures
2872	Potassic Chemical Fertilizers, except mixtures
2873	Phosphatic Chemical Fertilizers, except mixtures
2874	Phosphatic Fertilizers and Materials
2875	Ammonium Sulphate, All Grades
2876	Insecticides, Fungicides, Pesticides, and Disinfectants
2879	Fertilizers and Fertilizer Materials, NEC

Group 9--Milled Grain and Agricultural Products, NEC (Terminal Code A)

0101	Cotton, Raw
0121	Tobacco
0122	Hay and Fodder
0129	Field Crops, NEC
0131	Fresh Fruits and Tree Nuts, except Bananas and Plantains
0132	Bananas and Plantains
0133	Coffee, Green and Roasted
0134	Cocoa Beans

Group 9--(continued)

0141	Fresh and Frozen Vegetables
0151	Live Animals (Livestock)
0161	Animals and Animal Products, NEC
0191	Miscellaneous Farm Products
0911	Fresh Fish, except Shellfish
0912	Shellfish, except Prepared or Preserved
0913	Menhaden
2041	Wheat Flour and Semolina
2042	Prepared Animal Feeds
2049	Grain Mill Products, NEC

Group 10--Lumber and Wood Products (Terminal Code D)

0861	Forest Products, NEC
2411	Logs
2412	Rafted Logs
2413	Fuel Wood, Charcoal, and Wastes
2414	Timber, Posts, Poles, Pilings
2415	Pulpwood, Log
2416	Wood Chips, Stoves, Moldings, and Excelsior
2421	Lumber
2431	Veneer, Plywood, and Other Worked Wood
2611	Pulp

Group 11--Sugar and Molasses (Terminal Codes P and T)

2061	Sugar
2062	Molasses

Group 12--Primary Ferrous and Nonferrous Metal Products (Terminal Code H)

3311	Pig Iron
3314	Iron and Steel Ingots and Other Primary Forms
3315	Iron and Steel Bars, Rods, Shapes, Sections, including Sheet Piling
3316	Iron and Steel Plates and Sheets
3317	Iron and Steel Pipe and Tube
3318	Ferroalloys
3319	Primary Iron and Steel Products, NEC
3321	Primary Nonferrous Products, except Copper, Lead, Zinc, and Aluminum
3322	Copper
3323	Lead and Zinc
3324	Aluminum

Group 13--Fabricated Metal Products (Terminal Code A)

3411	Fabricated Metal Products, except Ordnance, Machinery, and Transportation Equipment
3491	Miscellaneous Fabricated Metal Products
3511	Machinery, except Electrical

Group 14--Scrap Metals (Terminal Code V)

4011	Iron and Steel Scrap
4012	Nonferrous Metal Scrap

Group 15--Construction Materials (Terminal Code G)

1411	Limestone Flux and Calcareous Stone
1412	Building Stone, Unworked
1421	Crushed and Broken Stone
1442	Sand, Gravel, Crushed Rock
2951	Asphalt Building Materials
3241	Cement
3271	Lime
3281	Cut Stone and Stone Products

Group 16--Mining Products, NEC (Terminal Code G)

0931	Marine Shells, Unmanufactured
1451	Clay, Ceramic, and Refractory Materials
1491	Salt
1492	Sulfur, Dry
1494	Gypsum, Crude Plasters
1499	Nonmetallic Minerals, except Fuels, NEC

Group 17--Non-Durable Manufacturers NEC, including Processed Foods (Terminal Code A)

2011	Meat; Fresh, Chilled, Frozen
2012	Meat and Meat Products, Prepared or Preserved, including Canned Meat Products
2014	Tallow, Animal Fats and Oils
2015	Animal By-Products, NEC
2021	Dairy Products, except Dried Milk and Cream
2022	Dried Milk and Cream
2031	Fish and Fish Products (including Shellfish), Prepared and Preserved
2032	Shellfish Products
2033	Vegetables, Canned
2034	Vegetables and Preparations, Preserved, Canned, and Otherwise
2035	Fruits, Frozen
2036	Fruits, Canned
2037	Fruit and Vegetable Juices
2039	Fruits and Fruit or Vegetable Juices, Canned
2081	Alcoholic Beverages
2082	Beverages--Non-Alcoholic, Flavored Syrup
2091	Vegetable Oils, All Grades; Margarine and Shortening
2092	Animal Oils and Fats, NEC including Marine
2093	Coffee, Roasted
2094	Groceries
2095	Ice

2099	Miscellaneous Food Products
2111	Tobacco Manufactures
2211	Basic Textile Products, except Textile Fibers
2212	Textile Fibers, NEC
2311	Apparel and Other Finished Textile Products, including Knits
2621	Newsprint (standard)
2631	Paper and Paperboard
2691	Pulp, Paper, and Paperboard Products, NEC
2711	Printed Matter
2831	Drugs
2841	Soap, Detergents, and Cleaning Preparations; Perfumes, Cosmetics and Other Toilet Preparations
3111	Leather and Leather Products

Group 18--Durable Manufactures, NEC (Terminal Code A)

0841	Crude Rubber and Allied Gums
1911	Ordnance and Accessories
2491	Wood Manufactures, NEC
2511	Furniture and Fixtures
2822	Synthetic Rubber
3011	Rubber and Miscellaneous Plastic Products
3211	Glass and Glass Products
3251	Structural Clay Products, including Refractories
3291	Miscellaneous Nonmetallic Mineral Products
3421	Cutlery, Hand Tools and General Hardware
3431	Plumbing Fixtures, Heating Equipment and Sanitary Equipment
3611	Electrical Machinery, Equipment, and Supplies
3711	Motor Vehicles, Parts, and Equipment
3721	Aircraft and Parts
3731	Ships and Boats
3791	Miscellaneous Transportation Equipment
3811	Instruments, Photographic and Optical Goods, Watches and Clocks
3911	Miscellaneous Products of Manufacturing

Group 19--Waste and Scrap Materials, Miscellaneous (Terminal Code S)

3312	Slag
4022	Textile Waste, Scrap and Sweepings
4024	Paper Waste and Scrap
4029	Waste and Scrap, NEC
4111	Water
4112	Miscellaneous Shipments, Unidentifiable by Commodity
4113	LCL Freight
4115	Vehicles
4116	Loaded Railroad Cars
4117	Empty Railroad Cars
9999	DOD Cargoes

Group 20--Waterway Improvement and Government Materials (Terminal Code S)

4118	Materials Used in Waterway Improvement, Government Materials

Exhibit II-3

MID-AMERICA PORTS STUDY

TERMINAL CODES

MarAd Code	Cargo Handling Description
A	General Cargo Only
B	Passenger/General Cargo
C	Passenger Only
D	Wood and Wood Products
E	Coal and Coke Products
F	Ores and Concentrates
G	Non-metallic Minerals (sand, gravel, rock, brick, clays, earth, gypsum, salt, dry sulfur, cement, limestone)
H	Iron, Steel and Mill Products
I	Fertilizers (nitrates, phosphates, potash)
J	Crude Petroleum
K	Refined Petroleum Products
L	Liquefied Natural Gas
M	Liquefied Propane Gas
N	Liquid Bulk Ores (nickel, cobalt, sulphides)
O	Grain
P	Bulk Raw Sugar
Q	Bauxite and Aluminum Ores
R	Liquefied Chemicals and Allied Products
S	Other
T	Molasses
U	Caustic Soda
V	Scrap Metal
W	Refrigerated

III. COMMODITY GROUP 1 - CASH GRAINS

Cash grains are those grains produced on a farm but not consumed on the producing farm. They are sold as a cash crop, usually on an open market.

The cash grains group includes:

0102 - Barley and Rye
0103 - Corn
0104 - Oats
0105 - Rice
0106 - Sorghums
0107 - Wheat
0109 - Grains, NEC
0111 - Soybeans
0112 - Flax Seed
0119 - Oilseeds, NEC

Cash grains are a natural commodity group within the criteria employed for grouping. The grains are all produced by the agricultural sector, have common demand variables, and are all transported, handled, and stored in the same types of specialized equipment and facilities.

Grain Production

The production of grains in the U.S. is dependent upon weather and soil conditions, as it is worldwide. However, in recent years the production of grains in the U.S. has additionally been affected greatly by foreign demand for grains and the resultant price fluctuations. Government loan and support price policies also affect the acreage alotted by farmers to grain production.

The three grain commodities that are of major importance to the inland waterway system are wheat, corn, and soybeans. Soybeans are considered as a grain here, although they are normally included with oilseeds such as flax and peanuts.

Exhibit III-1 shows the major corn, wheat and soybean producing states. Mid-America states account for over 70 percent of the corn and soybean production in the United States. Consequently, these two commodities are the largest waterway users in the cash grains group. Mid-America states account for slightly less than 50 percent of the U.S. wheat production and much of the production area is a substantial distance from the nearest waterway.

Kansas, as an example, is only bordered by the Missouri River on a portion of its eastern boundary, whereas the wheat producing areas of the state stretch over 400 miles south and westward to Colorado.

The other cash grains are produced in much smaller volume than these three commodities, and are grown in areas less accessible to the waterways.

Exhibit III-1

MAJOR CASH GRAIN PRODUCING STATES BY COMMODITY

1974

State	Production (000's bushels)	% of U.S. Total Production
	Corn	
Illinois	1,242,360	21.5
Iowa	1,091,700	18.9
Indiana	551,740	9.5
Nebraska	503,200	8.7
Minnesota	407,400	7.1
Ohio	321,080	5.6
Wisconsin	198,370	3.4
Missouri	170,100	2.9
Kansas	137,760	2.4
Texas	113,300	2.0
All Others	1,029,981	18.0
Total U.S. Production	5,766,991	100.0%
	Wheat	
Kansas	350,900	16.4
North Dakota	264,392	12.4
Oklahoma	160,800	7.5
Montana	155,925	7.3
Washington	145,140	6.8
Texas	131,100	6.2
Nebraska	98,240	4.6
Minnesota	87,839	4.1
Ohio	74,340	3.5
Illinois	67,470	3.2
All Others	597,657	28.0
Total U.S. Production	2,133,803	100.0%
	Soybeans	
Illinois	291,810	19.2
Iowa	236,980	15.5
Indiana	119,790	7.9
Missouri	113,985	7.5
Arkansas	112,800	7.4
Ohio	100,750	6.6
Minnesota	92,820	6.1
Mississippi	68,640	4.5
Tennessee	45,325	3.0
Louisiana	43,680	2.9
All Others	294,790	19.4
Total U.S. Production	1,521,370	100.0%

Source: Agricultural Statistics 1976, U.S. Department of Agriculture.

Grain Markets

The primary markets for U.S. grain growers are food processors, animal feed mills and exports. Exhibit III-2 shows the percentage of stocks entering each market for the year 1974.

Grains are distributed through a system of storage elevators. County elevators are located throughout the growing areas and purchase and/or store grains for local farmers. Normally these elevators are located on a railroad spur enabling them to reship the grain to subterminal and terminal elevators.

Basically the elevators on the continuum from country elevator to terminal elevator become larger in terms of storage capacity, and faster in terms of loading/unloading and drying capabilities.

Terminal elevators are most generally located on a railroad but many are located along waterways. These are the origination points of most waterborne shipments of grain. The terminal elevators ship to food and feed processors and to export elevators.

The areas with the largest terminal elevator capacity (combined) are Minneapolis, Chicago, St. Louis, and Kansas City, all of which are accessible by water. The single largest destination area of cash grain shipments is the Lower Mississippi River. Therefore, the largest volume of grain movements on the waterways is down the Mississippi River System to the New Orleans area. This demand in the

Exhibit III-2

U.S. CASH GRAIN MARKETS
1974
(millions of bushels)

	Food Processing	Animal Feed	Exports	Carry Over Stocks	Total Supply
Corn	441.0	320.0	1,149.0	359.0	5,149.0
Wheat	524.9	155.0	1,039.3	326.6	2,045.7
Soybeans	*	780.0	420.7	185.0	1,385.7
		Percent of Total			
Corn	8.6	62.1	22.3	7.0	100.0%
Wheat	25.7	7.6	50.8	15.9	100.0%
Soybeans	*	56.3	30.3	13.4	100.0%

*Soybeans utilized in food processing are included under animal feed. Soybean crushing results in soybean meal which is primarily used as animal feed, and soybean oil which is used primarily in food processing.

lower Mississippi is created by export sales. Several large export elevators are located on the Mississippi River between Baton Rouge and Myrtle Grove, La. where the controlling draft for vessels is 40 feet of fresh water.

Grain Transportation Characteristics

Grains are moved exclusively in dry bulk form. There are no particular precautions that must be taken when transporting grain other than to assure that it remains clean and dry.

The handling facilities for loading/unloading of grain at terminal and export elevators are specialized equipment which has greatly increased throughput capacity in recent years. Loading is normally achieved by belts and gravity flow whereas unloading of grain barges is accomplished with pneumatic and mechanical equipment.

Grain Movements

In 1976 the 43 million tons of grain shipped on the inland waterways represented 11 percent of the total tonnage. However, due to the length of the hauls, grain shipments represented over 18 percent of the total ton-miles in 1976.

Exhibit III-3 shows shipments of grain by state for 1976. Exhibit III-4 shows the growth in waterborne shipments of grain from 1969-1976. Grain is one of the fastest growing commodity groups. Over the past seven years it has grown in volume of movements at a compounded rate of 10.0 percent per year.

Exhibit III-3

CASH GRAIN SHIPMENTS
1976
(short tons)

	Inbound	Outbound	Intrastate
Alabama	1,244,185	367,188	493,239
Arkansas	29,879	1,533,068	0
Illinois	190,627	17,447,427	233,705
Indiana	138,519	1,250,248	0
Iowa	4,110	4,888,835	1,375
Kansas	1,150	89,026	0
Kentucky	36,248	1,097,222	4,522
Louisiana	37,952,746	356,246	1,076,322
Minnesota	1,633	5,747,251	29,275
Mississippi	821,834	683,242	64,333
Missouri	217,907	5,238,369	20,862
Nebraska	2,400	258,188	2,334
Ohio	4,469	1,300,208	0
Oklahoma	0	211,780	0
Pennsylvania	1,420	0	0
Tennessee	1,034,285	1,080,833	14,031
West Virginia	0	1,461	0
Wisconsin	2,708	570,956	0
Total	41,684,120	42,121,566	1,939,998

Source: Temple, Barker & Sloane, Inc.

Exhibit III-4

CASH GRAIN SHIPMENTS
1969-1976
(short tons)

	Inbound	Outbound	Intrastate	Total
1969	20,545,675	22,303,228	803,796	43,652,693
1970	21,590,652	23,244,256	769,448	45,604,335
1971	21,895,605	23,206,315	991,669	46,093,589
1972	28,915,146	29,632,604	1,051,635	59,599,385
1973	29,185,553	29,703,076	892,862	59,781,491
1974	30,746,383	31,414,142	1,465,359	63,625,884
1975	34,167,217	35,141,430	1,379,737	70,688,384
1976	41,684,120	42,121,566	1,937,664	85,743,350

Seven year compounded growth rate = 10.1 percent.

Source: Temple, Barker & Sloane, Inc.

The percentage composition of the cash grains group and the tons of each commodity moved on the inland waterways of the Mid-America Region in 1976 are shown in Exhibit III-5.

Exhibit III-5

PERCENTAGE COMPOSITION OF CASH GRAINS GROUP
1976
(short tons)

		Tons	Percent of Total
0102	Barley and Rye	22,537	--
0103	Corn	25,527,196	57.6
0104	Oats	132,954	.3
0105	Rice	177,272	.4
0106	Sorghums	177,272	.4
0107	Wheat	7,002,252	15.8
0109	Grains, NEC	--	--
0111	Soyabeans	11,168,148	25.2
0112	Flax Seed	--	--
0119	Oilseeds, NEC	88,636	.2
Total		44,318,049	100.0%

*Percentages obtained from Waterborne Commerce of the United States, 1976 Part 2, page 140. The tonnage figures were adjusted to reflect the boundaries of the 17 state Mid-America region.

IV. COMMODITY GROUP 2 - IRON AND NONFERROUS METAL ORES AND CONCENTRATES

This commodity group includes iron and all other nonferrous metal ores except aluminum. These commodities are primary raw material for the related metal. The commodities included are:

1011 - Iron Ore and Concentrates
1021 - Copper Ore and Concentrates
1061 - Manganese Ore and Concentrates
1081 - Chrome Ore and Concentrates
1091 - Nonferrous Metal Ores, NEC

These commodities have been grouped due to their common relationship to the primary metals industry. Furthermore, these commodities have similar handling characteristics and are normally transferred at the same types of terminals.

Iron ore production, markets, and transportation will be discussed separately due to the volume of total movements of iron ore in the U.S. Hence, the nonferrous metal ores will be discussed as a group.

U.S. Iron Ore Production

The United States' main source of domestic iron ore has been the Lake Superior Region. This region has produced over 80 percent of all domestically sourced iron ore for several decades. (See Exhibit IV-1.)

The balance of the U.S. production of iron ore occurs in 18 states. Sixteen percent of the U.S. production occurs in the Western states region which is inaccessible by the waterways.

The U.S. produces less iron ore than it presently consumes. (See Exhibit IV-2) The ore deficit is made up with foreign iron ore imports. In 1968, 35 percent of iron ore receipts were foreign imports. In 1976 the percentage of imports to total receipts was unchanged although in the interim there had been slight fluctuations. The U.S. foreign import of iron ore in 1976 originated as follows: Canada 56.2 percent, Venezuela 20.3 percent, Brazil 12.1 percent, Liberia 4.9 percent, and others 6.5 percent.

Iron Ore Markets

The only user of iron ore is the steel industry. Due to the huge volumes of ore and coke consumed annually, plant location is of vital importance to the competitive position of a steel producer. This has resulted in a concentration of the steel industry on the banks of the Great Lakes and in East and Gulf Coast ports where supplies of iron ore are readily available via low cost water transportation. Other steel mills located throughout the country are invariably located close to a local source of ore.

Near the Great Lakes, production from the superior Region and Canada is varied to meet the needs of the Great Lakes steel mills. In the U.S. East Coast ports of Wilmington, N.C., Baltimore, and Philadelphia, the steel mills are supplied with foreign imports of ore.

Exhibit IV-1

IRON ORE PRODUCTION BY STATE

1974

(thousands of long tons)

Lake Superior:	
Michigan/Minnesota	71,460
Wisconsin	956
Total	72,416
Northeastern States	
New York and Pennsylvania	*
Southeastern States	
Alabama, Georgia, North Carolina	317
Western States	
Missouri	2,625
Montana	13
Nevada	119
Utah	*
Wyoming	*
Others**	227
Total Reportable	2,984
Total Withheld All States	11,659
Grand Total All States	87,376

*Withheld to avoid disclosing individual company confidential data.

**Includes: Arizona, Arkansas, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.

Source: Minerals Yearbook, Volume 1, Metals, Minerals and Fuels, 1974; United States Department of the Interior, p. 670.

Exhibit IV-2

IRON ORE RECEIPTS AND CONSUMPTION

1976

(thousands of net tons)

	Original Source of Iron Ore							
	United States				Canada			
	Great Lakes (a)	North-eastern (b)	Southern (c)	Western (d)	Great Lakes (e)	Eastern (f)	All Other Foreign Countries	Total Iron Ore
Receipts at plants	71,481	1,961	3,678	7,352	5,053	21,390	20,906	131,821
Consumption in:								
Blast furnaces	63,674	1,058	3,005	6,096	4,732	12,004	10,879	101,448*
Steel producing furnaces	28	25	110	71		222	696	1,152
Agglomerating plants (g)	7,663	503	499	1,252	501	8,107	6,701	25,226
Total Consumption	71,365	1,586	3,614	7,419	5,233	20,333	18,276	127,826

(a) Michigan, Minnesota, Wisconsin.
(b) New England states, Delaware, New Jersey, New York, Pennsylvania.
(c) Florida, Alabama, Georgia, Missouri, New Mexico, Tennessee, Texas, Virginia.
(d) California, Nevada, Utah, Wyoming, Colorado, Montana, Washington.
(e) Ontario.
(f) Quebec, Newfoundland, Nova Scotia, Labrador, New Brunswick, Prince Edward Island.
(g) Represents plants at other than mine locations.
* Includes 83,846,000 N.T. of agglomerates produced at or near mine site.
Similar data not available prior to 1942.

Source: Annual Statistical Report, American Iron and Steel Institute, 1976, p. 69.

The steel mills in Texas and Alabama use local sources of ore supplemented by foreign imports.

Iron Ore Movements

It is from the imported iron ore that the movements of iron ore on the inland waterways originate. The major movements occur on the Black Warrior and Tombigbee Rivers in Alabama where 3.8 million tons of iron ore moved in 1976. These shipments originated in Mobile where ocean-going bulkers discharged iron ore which was later transferred to barges for upriver shipment. Less than 1 million tons of iron ore moved on the entire Mississippi River system. The movements that occurred, originated in the lower Mississippi River and terminated on the Ohio River or in the Pittsburgh area.

Iron Ore Transportation Requirements

Iron ore is transported in a dry bulk form. It is a very dense cargo stowing about 17 cubic feet per long ton and is normally discharged from vessels or barges with clamshell grabs.

Due to the low value of iron ore and its non-deteriorating nature, users stockpile large volumes of iron ore. These characteristics also impact on modal choice. The low value forces shippers to utilize the lowest cost mode of transportation and stockpiling alleviates the need for quick transit times. This results in iron ore moving on the waterways whenever possible provided the transfer costs between modes if required will be offset by the lower waterway line haul costs.

Railroads are the only other transportation mode used for line hauls of iron ore. Trucks are used only for local movements at steel mills.

Nonferrous Ores and Concentrates

Of the nonferrous metals, manganese ore moves in the largest volume on the inland waterways. The U.S. imports its entire need of manganese ore as virtually no known reserves exist in the United States.

The major consumer of manganese ore is the iron and steel industry. Manganese is used in making iron and steel castings. As a result of this situation, manganese ore movements occur from the lower Mississippi to the Ohio River and Pittsburgh area.

Copper ore and concentrates will not be discussed here due to the minimal volume of movements of this commodity on the inland waterways.

Other nonferrous metal ores do move on the inland waterways but in limited quantities. This would include lead, zinc, and chromium ores. In 1976 less than one million tons of these ores moved on the waterways. The principal movement of these ores was up the Mississippi to the Ohio River and Pittsburgh area. Other isolated movements of nonferrous ores occurred but in very limited volume.

Transportation Requirements of Nonferrous Metal Ores

All of the nonferrous metal ores are moved in dry bulk form. Their handling characteristics are basically the same as for iron ore.

One distinction which separates the ferrous and nonferrous ores is their value per ton. Nonferrous ores are higher in value in comparison to ferrous ores. As a result, the railroads are strong competitors for the nonferrous metal ores as they usually can provide quicker transit.

Iron and Nonferrous Metal Ore Movements

Exhibit IV-3 shows the shipments and receipts of this commodity group by state for 1976. Exhibit IV-4 shows the changes in volume of movements over the period of 1969-1976. The percentage composition of Commodity Group 2 and the tons of each commodity moved on the inland waterways of the Mid American Region in 1976 are shown in Exhibit IV-5.

Exhibit IV-3

SHIPMENTS AND RECEIPTS OF
IRON AND NONFERROUS METAL ORES
1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	46,575	36,558	3,866,362
Arkansas	12,987	0	0
Illinois	6,038,148	27,200	1,122
Indiana	1,627	0	0
Iowa	584	2,851	0
Kansas	0	0	0
Kentucky	152,899	6,319	0
Louisiana	106,446	1,964,011	150,001
Minnesota	0	38,343	0
Mississippi	49,113	13,013	0
Missouri	56,139	38,917	0
Nebraska	546	0	0
Ohio	776,832	53,434	0
Oklahoma	1,202	0	0
Pennsylvania	520,627	168,204	0
Tennessee	392,398	4,680	0
West Virginia	110,831	28,453	0
Wisconsin	0	0	0
Total	8,266,954	2,381,983	4,017,485

Source: Temple, Barker and Sloane, Inc.

Exhibit IV-4

SHIPMENTS OF IRON ORE AND NONFERROUS METAL ORES

1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	10,931,622	1,753,687	2,005,085	14,690,394
1970	11,593,918	2,060,154	1,923,596	15,577,668
1971	9,950,836	2,340,834	2,482,423	14,774,093
1972	8,663,724	2,088,885	2,908,197	13,660,806
1973	9,613,798	1,974,387	3,169,535	14,757,720
1974	9,397,713	2,194,886	4,263,911	15,856,510
1975	8,421,262	2,256,010	2,460,918	13,138,190
1976	8,265,327	2,381,983	4,017,485	14,664,795

Source: Temple, Barker and Sloane, Inc.

Exhibit IV-5

PERCENTAGE COMPOSITION OF
IRON AND NONFERROUS METAL ORES GROUP
1976

		Short Tons*	Percent*
1011	Iron Ore & Concentrates	10,724,753	86.7
1021	Copper Ore & Concentrates	--	--
1061	Manganese Ore & Concentrates	832,850	6.7
1081	Chrome Ore & Concentrates	--	--
1091	Nonferrous Metal Ores, NEC	797,279	6.4
Total		12,363,046	100.0%

*Percentages obtained from Waterborne Commerce of the United States, 1976 Part 2, page 140. The tonnage figures were adjusted to reflect the boundaries of the 17 state Mid-America region.

V. COMMODITY GROUP 3 - BAUXITE AND OTHER ALUMINUM ORES AND CONCENTRATES

Bauxite and other aluminum ores are the primary raw material input to the aluminum industry. This commodity group includes only CCSS 1051, Bauxite and Other Aluminum Ores and Concentrates.

The Army corps of Engineers classify bauxite ore and alumina (an ore concentrate) together and maintain aggregate statistics on their movements; therefore, the two commodities must be considered as one. Bauxite and alumina are not grouped with the other metal ores as the handling characteristics are substantially different, as discussed in "Transportation Requirements" of this section.

Bauxite and Alumina Production

Bauxite deposits are located mainly in tropical and subtropical areas. Very limited quantities are located in the U.S., mainly in Arkansas. Consequently, the U.S. aluminum industry imports about 90 percent of its bauxite and alumina requirements. This figure is likely to increase as the reserves in Arkansas are depleted. Presently, the main sources of U.S. imports are Jamaica, Surinam, Haiti, and Guinea.

Bauxite ore in its raw form is about 50 percent unrecoverable waste, therefore the ore is crushed, washed, and refined to alumina. This is often done near the mine

to reduce the total weight and volume requiring transportation to the reduction facilities. About two pounds of bauxite are required to obtain one pound of alumina.

Alumina in turn is electrolytically reduced to aluminum. About two pounds of alumina and 7.5 kilowatts of electricity are required to produce one pound of aluminum metal.

Bauxite and Alumina Markets

Bauxite conversion plants are located in Arkansas where they use local bauxite. Plants located in the Gulf Coast states of Texas, Louisiana and Alabama are all accessible to ocean traffic and use imported bauxite.

Due to the large quantities of electrical energy required to reduce alumina, reduction facilities are normally located near sources of low cost electricity. Several reduction plants are located in the states of Washington and Oregon, which have the lowest cost electrical energy. Others are located in Tennessee, North Carolina, New York, Indiana, Alabama, Arkansas, Texas, Louisiana, West Virginia, Ohio and Montana.

Transportation Requirements and Movements

Bauxite has much the same handling characteristics as other metal ores although it is bulkier. Bauxite is moved in dry bulk form and grabs are normally used for discharging operations.

Alumina has substantially different handling characteristics from the other metal ores and concentrates. Alumina is light and very powdery. It is most efficiently discharged with pneumatic equipment although buckets are also used. For this reason the terminals handling alumina usually are specialized for that purpose.

Internal traffic of bauxite is miniscule, although large volumes of bauxite move in oceangoing bulk carriers to the bauxite conversion plants located in the Gulf Coast states.

Internal waterborne movements of alumina are larger than those of bauxite but still relatively small. In 1976, 420,000 tons of bauxite and alumina moved in internal traffic. Most of this movement occurred between the lower Mississippi River bulk handling facilities which discharged the ore from ocean vessels to barges for transshipment to reduction plants in Arkansas. (See Exhibit V-1.)

About 15.2 million short tons of bauxite and alumina moved in total waterborne commerce in the U.S. in 1975. The difference in this figure and the internal waterborne movements is the foreign imports of bauxite which are principally received in Texas, Louisiana and Alabama.

The bauxite and aluminum ores group represent a very small percentage (less than .2 percent) of total internal traffic. Furthermore, this group has not shown a sustained growth pattern over the past eight years as evidenced by Table V-2. However, some future growth may be expected

if waterborne movements increase with the increased use of aluminum. This will depend largely on future reduction plant locations.

Exhibit V-1

BAUXITE AND ALUMINUM ORE SHIPMENTS

1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	0	6,028	0
Arkansas	377,432	0	0
Illinois	1,490	0	0
Indiana	0	0	0
Iowa	0	0	0
Kansas	0	0	0
Kentucky	1,439	0	0
Louisiana	354	412,877	0
Minnesota	0	0	0
Mississippi	0	0	0
Missouri	0	0	0
Nebraska	0	0	0
Ohio	4,184	0	0
Oklahoma	0	0	0
Pennsylvania	0	0	0
Tennessee	0	0	0
West Virginia	0	0	0
Wisconsin	0	0	0
Total	384,953	418,905	0

Source: Temple, Barker and Sloane, Inc.

Exhibit V-2

BAUXITE AND ALUMINUM ORE SHIPMENTS

1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	0	668,144	0	668,144
1970	905,382	877,237	0	1,782,619
1971	362,627	395,489	0	758,116
1972	75,288	75,288	0	150,576
1973	289,574	312,348	0	601,922
1974	529,818	581,352	0	1,111,170
1975	386,759	444,627	0	831,386
1976	384,899	418,905	0	803,804

Source: Temple, Barker and Sloane, Inc.

VI. COMMODITY GROUP 4
COAL AND COAL PRODUCTS

This commodity group includes:

1111 Anthracite coal

1121 Coal and Lignite

2920 Coke, including petroleum coke

3313* Coke (coal and petroleum), petroleum pitches and asphalts, and Naptha and Solvents

Coke and coal were both placed in this group as they use the same type of cargo handling terminals, have the same basic handling characteristics, and some of the economic variables affecting demand are the same.

Exhibit VI-1 presents the breakdown of the coal and coal products groups by tons and by percent.

COAL PRODUCTION

Known coal reserves are found in 31 of the 50 United States. Production, however, is concentrated in a few states, with 16 states accounting for 96 percent of the annual U.S. coal production. Exhibit VI-2 shows U.S. coal production for 1974 by state.

*This CCSS category is included with Commodity Group 4 as it includes coke. It should be noted that all movements of CCSS 3313 are either exports or imports and consequently their movements are in ocean vessels in and out of seaports.

Exhibit VI-1

PERCENTAGE COMPOSITION OF
THE COAL AND COAL PRODUCTS GROUP
1976

		Short Tons*	Percentage*
1111	Anthracite Coal	0	--
1121	Coal and Lignite	129,652,177	98.7
2920	Coke and Petroleum Coke	1,707,678	1.3
3313	Coke, Pitches, Asphalt	0	--
Total		131,359,855	100.0%

*Percentages obtained from Waterborne Commerce of the United States, 1976 Part 2, page 140. The tonnage figures were adjusted to reflect boundaries of the 17 state Mid-America region.

Exhibit VI-2

COAL PRODUCTION BY STATE

1974

(thousands of short tons)

State	Production	Percent of Total U.S. Production
Alabama	19,824	3.3
Alaska	700	.1
Arizona	6,448	1.1
Arkansas	455	--
Colorado	6,896	1.1
Illinois	58,215	9.6
Indiana	23,726	3.9
Iowa	590	.1
Kansas	718	.1
Kentucky	137,197	22.7
Maryland	2,337	.4
Missouri	4,623	.8
Montana	14,106	2.3
New Mexico	9,392	1.6
North Dakota	7,463	1.3
Ohio	45,409	7.5
Oklahoma	2,356	.4
Pennsylvania	80,462	13.3
Tennessee	7,541	1.3
Texas	7,684	1.3
Utah	5,858	1.0
Virginia	34,326	5.7
Washington	3,913	.7
West Virginia	102,462	17.0
Wyoming	20,703	3.4
Total	603,406	100.0%

Source: Minerals Yearbook, 1974, Bureau of Mines, U.S. Department of the Interior.

Coal production in the U.S. is expected to grow to 1.2 billion tons by 1985 or a 100 percent increase over 1974 production. This projected growth will come mainly from the western states of Montana and Wyoming, which are rich in low sulphur coal reserves. Coal in the Western states is mined primarily at the surface and therefore increases in production are much easier to achieve than are rapid increases in underground mining. In 1974, 54 percent of all coal mined in the U.S. was mined at the surface through either strip mining or auger mining.

COAL MARKETS

The composition of coal markets is undergoing radical changes as the utilities switch from oil to coal. As can be seen in Exhibit VI-3, the utilities accounted for about 18 percent of U.S. coal consumption in 1950. By 1975 the utilities' consumption had increased to 64.3 percent of the total and this is expected to continue to rise to about 70 percent by 1985.[1] Exhibit VI-4 shows the percentage change in coal uses since 1950 and the expected use in 1985.

Table VI-5 shows the distribution of coal in the U.S. for 1974, by state or region with percentage equivalents for the entire regions.

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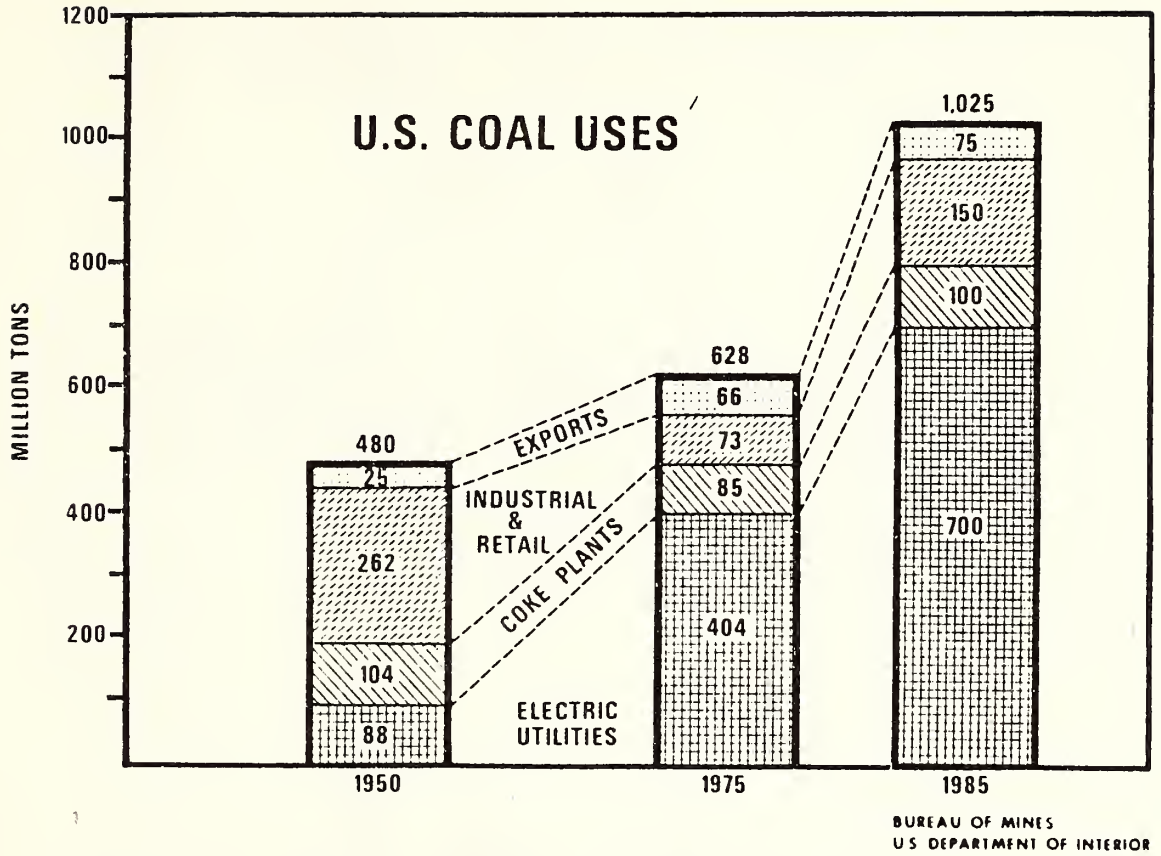
[1] Mineral Facts and Problems, 1975, Bureau of Mines, U.S. Department of the Interior, p. 168.

Exhibit VI-3

U.S. COAL USES*

1950-1985



*Mineral Facts and Problems, 1975 Edition, Bureau of Mines, U.S. Department of the Interior, p. 168.

Exhibit 4

U.S. COAL USES
(percentage)

	1950	1975	1985
Utilities	18.4	64.5	68.3
Coke and Gas Plants	21.7	13.4	9.8
Industrial and Retail	54.6	11.6	14.6
Exports	5.3	10.5	7.3

Figures derived from Exhibit VI-3.

Exhibit VI-5

COAL DISTRIBUTION BY STATE/REGION

Region/State	Tons (000's short tons)	Percent of Total U.S. Production
New England	2,055	.3
Middle Atlantic		
New York	14,742	
New Jersey	3,058	
Pennsylvania	63,322	
Total	81,122	13.5
East North Central		
Ohio	69,642	
Indiana	43,921	
Illinois	39,054	
Michigan	29,250	
Wisconsin	12,335	
Total	194,202	32.2
West North Central		
Minnesota	9,668	
Iowa	6,589	
Missouri	17,844	
North Dakota	5,812	
South Dakota	442	
Nebraska	1,786	
Kansas	1,825	
Total	43,966	7.3
South Atlantic		
Delaware	795	
Maryland	8,896	
District of Columbia	496	
Virginia	7,410	
West Virginia	33,784	
North Carolina	21,337	
South Carolina	8,061	
Georgia	10,766	
Florida	6,259	
Total	97,804	16.2
East South Central		
Kentucky	25,445	
Tennessee	18,916	
Alabama	25,125	
Mississippi	1,594	
Total	71,080	11.8
West South Central		
Arkansas	112	
Louisiana	--	
Oklahoma	175	
Texas	8,607	
Total	8,894	1.5
Moutain States	34,972	5.8
Pacific States	6,500	1.1
Alaska	690	.1
Canada	13,619	2.3
Mexico	411	--
Export	45,809	7.5
Other (Net)	2,355	.4
Grand Total	603,479	100.0%

Source: U.S. Department of the Interior, Bureau of Mines, Mineral Yearbock 1974.

COAL TRANSPORTATION

Coal is moved almost exclusively in dry bulk form. On the average, a ton of coal occupies slightly less than 40 cubic feet per ton. It is normally loaded with conveyor belt system or some type of gravity flow system. Coal is normally discharged from barges with clamshell grabs or at more modern facilities with endless bucket unloading systems.

The one exception to coal being moved in dry bulk form is the movement of coal by slurry pipelines.

The production and movements of coal are quite stable throughout the year with the exception of the month of July when many mines are shut down for miner's vacations. Movements are sometimes also disrupted in the Upper Mississippi River System during severe cold spells such as January of 1977, due to the freezing of the rivers.

The stable production, consumption and movements of the coal industry has resulted in coal being hauled under long term contracts rather than on a spot basis.

COKE, COAL AND PETROLEUM

Coke is a production of coal or petroleum. Over 80 percent of the coke production in this country is used in the production of pig iron which in turn is used in producing raw steel.

Coke Production

Coke is produced from metallurgical coal by heating the coal in the absence of air. This process forces much of the gas, coal tar and light oil out of the coal. It also melts the coal which then resolidifies into the hard porous substance, coke.

There are two types of coke production, oven-coke and beehive coke. Oven-coke represents about 99 percent of total coke production.

The term "furnace" is used to refer to oven-coke plants owned or operated by steel companies with the production being used in their own blast furnaces. "Merchant" oven-coke plants produce coke for sale on the open market. Ninety-two percent of the coke produced in the U.S. in 1974 was produced by furnace plants.[2]

Coke Markets

The primary user of coke is the steel industry which consumed 90 percent of total production in 1975. Other users include the chemical industry, foundry operators, and residential heating. There are also small volumes of coke traded internationally.

The market for coke is very limited as the integrated steel companies produce coke to meet most of their own requirements. These companies may purchase quantities of

[2]U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook 1974, p. 452.

coke from merchant plants to supplement their own production or sell coke to companies outside the steel industry if they have excess coke capacity. It is this intercompany trade and international trade give rise to most of the internal waterway coke movements.

With the primary end user of coke being the steel industry, the majority of the coke production capacity is located in the steel producing states. The four states of Pennsylvania, Ohio, Indiana, and Alabama accounted for 63 percent of the total coke production.[3]

Exhibit VI-6 shows total production and consumption of coke by state. It is interesting to note in the states where full data is available how closely state production parallels state consumption. This situation leads to very small volumes of interstate coke movement.

Coke Transportation Requirements and Movements

Coke has much the same handling characteristics as coal except that it is somewhat lighter as much of the gas, tar and oil in the coal has been removed. It is moved in dry bulk form and normally discharged with grabs.

About 1.7 million tons of coke moved in internal traffic in 1976. Almost all of this movement was on the Ohio and Mississippi Rivers and Gulf Intracoastal Waterway.

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[3]U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1973, p. 428

Exhibit VI-6

COKE PRODUCTION AND CONSUMPTION[1]

1973

(thousands of short tons)

State	Produced	Consumed In		
		Blast Furnaces	Other Uses	Total
Pennsylvania	16,710	16,386	945	17,331
Ohio	9,438	8,296	1,230	9,526
Indiana	9,335	9,067	--*	9,067
Alabama	5,132	3,191	1,951	5,142
Michigan	3,871	--*	--*	--*
Minnesota, W. Virginia Wisconsin	4,677	4,228	559	4,787
Maryland and New York	7,070	6,745	--*	6,745
Illinois	1,941	1,974	--*	1,974
California, Utah, and Colorado	3,386	3,745	--*	3,345
Kentucky, Tennessee, Missouri, Texas	1,936	--*	--*	--*
Undistributed		4,128	2,094	7,032
Total	63,496	57,360	7,589	64,949

*Included with "undistributed" to avoid disclosing individual company data.

[1]Minerals Yearbook, 1973, Bureau of Mines, U.S. Department of the Interior, p. 460.

Exhibit VI-7 shows all waterborne shipments for 1976 by state. These movements are also depicted on the map shown in Exhibit VI-8. As might be expected, the highest density of waterborne coal movements occur on the rivers in the major coal production or consumption states.

In 1976 the coal and coal products group represented 29.6 percent of the total tonnage moved on the inland waterways in the study area which makes it the most important to the inland waterways in terms of total tonnage moved.

Exhibit VI-9 shows the growth of coal movements on the waterways between the years of 1969 and 1976.

Exhibit VI-7

COAL AND COAL PRODUCTS SHIPMENTS
1976
(short tons)

	Inbound	Outbound	Intrastate
Alabama	421,456	1,401,867	9,148,983
Arkansas	0	54,189	0
Illinois	2,707,155	13,285,970	6,185,226
Indiana	6,002,449	3,233,805	1,919,778
Iowa	1,196,730	2,906	5,464
Kansas	0	0	0
Kentucky	3,900,878	25,701,167	966,859
Louisiana	4,640,182	2,988,410	329,734
Minnesota	1,613,319	757,494	1,577,813
Mississippi	1,388,428	0	0
Missouri	3,763,667	3,123,214	535,937
Nebraska	0	0	0
Ohio	14,712,209	1,676,205	8,112,739
Oklahoma	0	180,575	0
Pennsylvania	10,471,416	2,142,912	18,912,876
Tennessee	9,007,594	814,127	19,542
West Virginia	3,768,569	19,604,751	8,267,409
Wisconsin	1,579,641	0	0
Total	65,825,364	74,967,592	55,982,360

Source: Temple, Barker & Sloane, Inc.

Exhibit VI-8

Source: Coal Age, December 1977, p. 123.

Exhibit VI-9

COAL AND COAL PRODUCTS SHIPMENTS
1969-1976
(short tons)

	Inbound	Outbound	Intrastate	Total
1969	51,133,245	61,837,829	49,528,511	162,499,585
1970	53,719,566	65,137,084	51,693,668	170,550,318
1971	52,872,831	63,785,685	47,191,749	163,850,265
1972	61,785,978	72,891,694	51,077,228	185,754,900
1973	51,322,536	68,534,925	50,394,214	176,251,675
1974	59,869,136	70,100,112	51,039,979	181,009,227
1975	65,135,007	74,769,538	55,611,468	195,516,013
1976	65,825,364	74,967,592	55,982,360	196,775,316

Compounded 7 year growth rate equals 2.8 percent.

Source: Temple, Barker and Sloane, Inc.

VII. COMMODITY GROUP V - CRUDE PETROLEUM

This commodity group includes only CCSS 1311 Crude Petroleum. Crude petroleum has been isolated as a one commodity group due to the volume of crude oil movements in the United States, the distinct transportation requirements associated with crude oil, and its importance to the inland waterways.

Crude Petroleum Production

United States crude petroleum production peaked in 1970 at 3,517 million barrels. In 1974, the U.S. produced 3,202 million barrels of crude, down 9 percent from the 1970 maximum production. This decline is due to the exhaustion of old oil fields and the slower rate of discoveries.

Exhibit VII-1 shows total domestic production, number of wells producing, and average production per well for the years 1969 through 1974. The number of producing wells has been declining steadily since 1969. The average production per well has remained relatively constant since 1970.

Presently 31 states have proven reserves of crude petroleum, however, oil is produced in only 30 states. Exhibit VII-2 shows proved reserves as of January 1, 1976 in the 31 states and the crude oil production for 1975 by state. Exhibit VII-3 shows production by state as a percent of total U.S. crude petroleum production for the largest producing states.

Exhibit VII-1
(barrels per day)

	1969	1970	1971	1972	1973	1974
Total Domestic Production[1]	3,371,151	3,517,450	3,453,914	3,455,318	3,360,903	3,206,012
Number of Wells[2]	547,227	530,990	517,218	508,443	497,378	497,631
Average Well Production[3]	6,218	6,624	6,676	6,795	6,757	6,442

[1]Source: U.S. Department of the Interior, Bureau of Mines, Mineral Yearbook, 1973, p. 905, and Mineral Yearbook, 1974, p. 983.

[2]Ibid., (Number of wells producing at year end).

[3]Ibid., Total production for year divided by number of wells producing at year end.

Exhibit VII-2

U.S. RESERVES AND PRODUCTION OF CRUDE PETROLEUM

(thousands of barrels)

State	Proved Reserves[1] as of January 1, 1976		Production[2] 1974
Alabama	61,032		13,323
Alaska	10,037,262		70,603
Arkansas	95,662		16,527
California	3,647,537		323,003
Colorado	276,066		37,508
Florida	262,529		36,351
Illinois	160,986		27,553
Indiana	22,029		4,919
Kansas	364,394		61,691
Kentucky	39,306		7,837
Louisiana	3,827,187		737,324
Michigan	93,312		18,021
Mississippi	231,158		50,779
Montana	163,968		34,554
Nebraska	28,372		6,611
New Mexico	588,110		98,695
New York	10,024		896
North Dakota	158,245		19,687
Ohio	121,263		9,088
Oklahoma	1,239,687		177,785
Pennsylvania	48,028		3,478
South Dakota	1,855		494
Tennessee	1,508		769
Texas	10,080,035		1.262,126
Utah	208,318		39,363
West Virginia	31,418		2,665
Wyoming	877,385		139,997
Others[3]	5,441		928
Total Reserves	32,682,127	Total Domestic Production	3,202,585

[1]Source: The Oil and Gas Journal, April 5, 1976, p. 82.

[2]Minerals Yearbook, 1974, Bureau of Mines, U.S. Department of the Interior, pp. 977-978.

[3]Includes: Arizona, Missouri, Nevada, and Virginia.

Exhibit VII-3

PERCENTAGE OF TOTAL U.S. CRUDE PETROLEUM
PRODUCED, BY STATE, 1974

State	Percentage of Total
Texas	39.4
Louisiana	23.0
California	10.0
Oklahoma	5.5
Wyoming	4.4
New Mexico	3.1
Alaska	2.2
Kansas	1.9
Mississippi	1.6
All Others	8.8
	100.0

Source: Minerals Yearbook, 1974, Bureau of Mines,
U.S. Department of the Interior

On the consumption side, the United States has been increasing its annual consumption of crude oil at an annual rate in excess of 4 percent. Exhibit VII-4 shows U.S. consumption of crude (Total Sources) for the years 1970-1974. Consumption in 1974 dropped partially due to the Arab Oil Embargo and partially due to the economic recession. Otherwise, the years 1970-1973 clearly portray the upward consumption trend.

To fill the deficit created by falling domestic production and rising consumption, the United States imports nearly 40 percent of its crude petroleum. Exhibit VII-4 shows the absolute volume of imports, and the U.S. imports as a percent of total consumption for the years 1970-1974.

Exhibit VII-4

CRUDE OIL SOURCES[1]
(millions of barrels)

	1970	1971	1972	1973	1974
Domestic Production[2]	4,127	4,076	4,102	4,005	3,830
Imports[2]	1,247	1,431	1,734	2,281	2,221
Total Sources (consumption)	5,374	5,507	5,836	6,286	6,051
Imports as percent of Total	23.2	25.9	29.7	36.2	36.7

[1]Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1974, p. 970.

[2]Domestic Production includes crude petroleum, lease condensate, Natural Gas plant liquids and other hydrocarbons and hyrdrogen refining input. Imports include crude oil, unfinished oils, plant condensate and refined products.

Crude Petroleum Markets

Petroleum refineries are the only users of crude petroleum. As a result, the demand for crude petroleum is directly related to the demand for refined petroleum products.

There is refining capacity located in 40 states. Exhibit VII-5 details the crude petroleum consumption by state. Not surprisingly, District III, which is comprised of Texas, Louisiana, Alabama, Arkansas, Mississippi and New Mexico, accounts for 42 percent of the total refining activity in the United States. As was noted in Exhibit VII-3, these states also account for over 65 percent of U.S. domestic crude production. As a result, there are large volumes of movements of both crude oil and refined products from this district to the crude deficit districts.

Crude Petroleum Transportation

Crude petroleum is transported in a liquid form only. Some types of crude require heating to maintain the proper viscosity for pumping. Other characteristics of crude petroleum such as wax and sulphur content vary depending on the origination of the crude oil and can affect handling requirements.

Crude petroleum is transported on the waterways in barges of single skinned construction. The barges may or may not be compartmented. Some of these barges are equipped with heating coils to maintain heat when required for pumping.

Exhibit VII-5

CRUDE PETROLEUM CONSUMPTION
BY STATE, 1974[1]

State		Consumption (000's barrels)
District I		
Delaware, Maryland		53,034
Florida, Georgia and Virginia		21,927
New Jersey, Rhode Island		188,896
New York		32,161
Pennsylvania:		
East		190,796
West		21,828
West Virginia		5,539
	Total	514,181
District II		
Illinois		362,007
Indiana		156,292
Kansas		133,851
Kentucky, Tennessee		62,082
Michagan		43,255
Minnesota and Wisconsin		64,261
Missouri and Nebraska		31,899
North Dakota and South Dakota		16,927
Ohio:		
East		20,845
West		157,953
Oklahoma		167,166
	Total	1,216,538
District III		
Alabama		11,876
Arkansas		19,452
Louisiana		535,220
Mississippi		85,430
New Mexico		22,417
Texas		1,188,124
	Total	1,862,519
District IV:		
Colorado		14,393
Montana		40,771
Utah		43,008
Wyoming		55,271
	Total	153,443
District V:		
California		541,548
Other States		140,497
	Total	682,045
	Total United States	4,428,726

[1]Minerals Yearbook, 1974; Bureau of Mines, U.S. Department of the Interior, p. 990.

Crude Petroleum Movements

Exhibit VII-6 portrays the crude oil shipments between the PAD Districts. The most notable flow occurs between PAD District III and PAD District II. The 1,504,000 barrels per day equates to nearly 82 million tons per year.[1] The PAD Districts are delineated in Exhibit VII-7.

Pipelines account for a major portion of this movement. In 1974, 70.4 percent of refinery recepts were by pipeline.

From Exhibit VII-8 it is apparent that the highest volume of inland waterway movements of crude oil occur in Louisiana. The majority of these movements originate from the Mississippi Delta region oil fields and terminate at local oil refineries (intrastate movements).

Small volumes of crude petroleum are also moved on the inland waterways from Louisiana to Mississippi, Tennessee, Minnesota and Illinois.

Exhibit VII-9 shows the total volume of crude movements on the inland waterways from 1969 to 1976. The volume of crude petroleum has been falling at a compounded rate of 8.6 percent annually.

However, even with this lost volume, crude petroleum represented 7.6 percent of the total tons transported on the Mid America inland waterways in 1976.

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[1]Assumes 6.7 Barrels of Crude per ton.

Exhibit VII-6

INTER-PAD DISTRICT SHIPMENTS
OF IMPORTS OF CRUDE PETROLEUM 1974[1]
(thousand barrels per day)

Shipping PAD District	Receiving PAD District I	II	III	IV	V	Total United States
I	-	-	80	-	-	-
II	38	-	19	-	-	-
III	153	1,504	-	-	2	-
IV	1	268	15	-	39	-
V	-	-	-	-	-	-
Imports	1,174	687	795	45	776	3,477

[1]Minerals Yearbook, 1974, Bureau of Mines, U.S. Department of the Interior, p. 992.

Exhibit VII-7

PETROLEUM ADMINISTRATION FOR DEFENSE (PAD) DISTRICTS

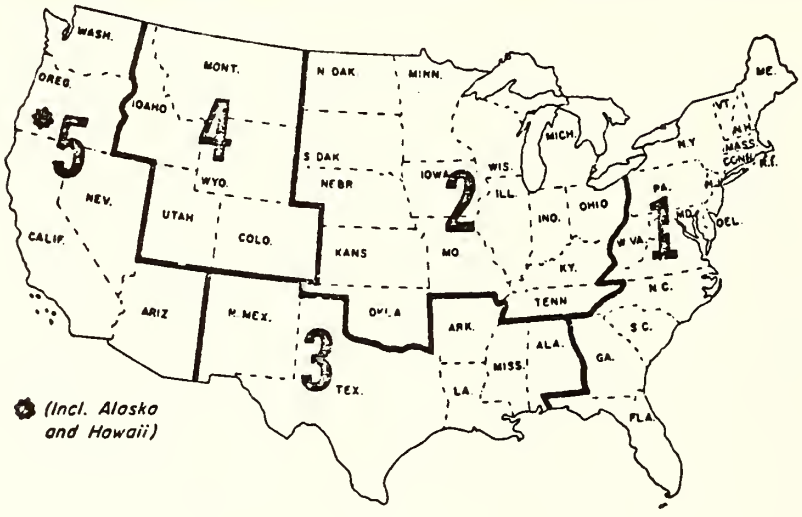


Exhibit VII-8

SHIPMENTS AND RECEIPTS OF
CRUDE PETROLEUM BY STATE

1976

(short tons)

State	Inbound	Outbound	Intrastate
Alabama	421,456	3,810,397	663,104
Arkansas	33,340	12,513	0
Illinois	150,362	116,431	10,571
Indiana	484,493	0	0
Iowa	0	0	0
Kansas	0	0	0
Kentucky	228,058	0	0
Louisiana	3,057,872	9,353,347	17,814,504
Minnesota	574,872	9,374	0
Mississippi	1,294,092	177,629	0
Missouri	21,198	0	0
Nebraska	0	0	0
Ohio	3,365	0	0
Oklahoma	0	0	0
Pennsylvania	4,490	0	0
Tennessee	1,957,773	0	0
West Virginia	162,876	0	0
Wisconsin	0	0	0
Total	8,393,653	13,479,691	18,488,179

Source: Temple, Barker & Sloane, Inc.

Exhibit VII-9

SHIPMENTS OF CRUDE PETROLEUM
1969-1976
(short tons)

Year	Inbound	Outbound	Intrastate	Total
1969	8,041,428	42,819,164	25,016,375	75,876,967
1970	8,257,738	42,962,375	26,066,738	77,286,861
1971	9,169,332	43,936,734	27,434,135	80,540,201
1972	12,148,833	33,272,236	27,431,995	72,853,064
1973	7,858,599	24,554,025	25,966,190	58,378,814
1974	5,474,395	19,288,507	20,728,319	45,491,221
1975	8,015,016	17,248,096	19,800,986	45,064,098
1976	8,393,653	13,479,691	18,488,174	40,361,523

Source: Temple, Barker & Sloane, Inc.

VIII. COMMODITY GROUP 6 - PETROLEUM PRODUCTS AND LUBRICANTS

The petroleum products and lubricants (hereafter referred to as petroleum products) group includes the following CCSS classifications:

2911 Gasoline, including natural gasoline
2912 Jet Fuel
2913 Kerosine
2914 Distillate Fuel Oil
2915 Residual Fuel Oil
2916 Lubricating Oils and Greases
2917 Naptha, Mineral Spirits, Solvents, NEC
2918 Asphalt, Tar and Pitches
2921 Liquefied Petroleum Gases, Coal Gases, Natural Gas, and Natural Gas Liquids
2911 Petroleum and Coal Products, NEC

The commodities in this group have similar handling characteristics, are handled at the same types of specialized terminals, and are all products of the petroleum refining industry. As such, the group can be matched to a specific terminal type and growth can be forecast using the demand for petroleum products as an independent variable.

Exhibit VIII-1 shows the total tons of movement of each commodity within the Petroleum Products group, and the percent of the group each commodity represents.

PETROLEUM PRODUCTS AND LUBRICANTS PRODUCTION

Gasoline is the most important refined product in terms of volume. In 1974 gasoline represented 49.1 percent of the total output of U.S. refineries. Figure VIII-1 charts the percentage yields of refined products from crude oil in 1974.

Statistics on gasoline production and consumption are shown in Exhibit VIII-2. The production of other refined products by state are in the same relative proportion to gasoline as shown in Exhibit VIII-1.

The United States refined over 96 percent of its domestic requirements of gasoline in 1974. The balance of 4 percent was imported through East Coast ports from Caribbean refineries.

U.S. refineries are operated to obtain the highest yield possible from the crude petroleum refined. In recent years the U.S. refineries have consistently produced over 45 percent gasoline. This compares to foreign refineries which may get as low as 10 percent gasoline from the crude. This percentage yield of gasoline from crude petroleum depends on the sophistication of the refinery equipment and the quality of the crude petroleum being refined.

Exhibit VIII-1

PERCENTAGE COMPOSITION OF
THE REFINED PETROLEUM PRODUCTS GROUP
1976

Commodity	Short Tons*	Percentage of Total*
Gasoline	28,859,278	33.0
Jet Fuel	2,448,666	2.8
Kerosine	612,166	.7
Distillate Fuel Oil	18,277,543	20.9
Residual Fuel Oil	26,148,255	29.9
Lubricating Oils	2,536,118	2.9
Naptha, Mineral Spirits, Solvents	1,661,594	1.9
Asphalt	3,935,356	4.5
Liquefied Petroleum Gases	1,661,595	1.9
Petroleum and Coal Products, NEC	1,311,785	1.5
Total	87,452,357**	100.0

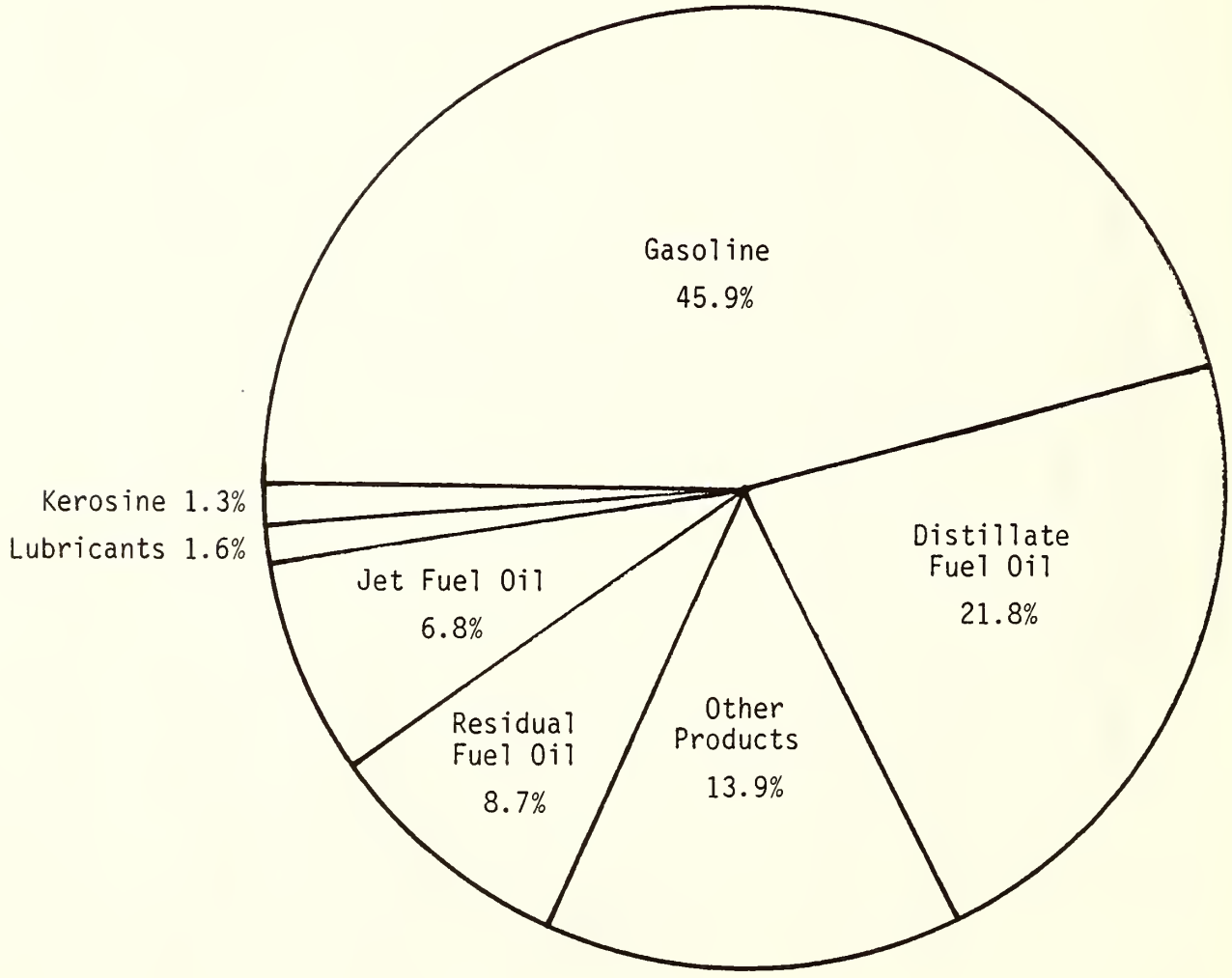
*Percentages obtained from the Waterborne Commerce of the United States, 1976, Part 2. The tonnage figures were adjusted to reflect the boundaries of the 17 states Mid-America Region.

**May not add due to rounding.

Source: Temple, Barker and Sloane, Inc.

Figure VIII-1

COMPOSITION OF UNITED STATES
REFINERY OUTPUT, 1974



Source: Minerals Yearbook, 1974
Bureau of Miner, U.S. Department of the Interior, p. 1002.

Exhibit VIII-2

GASOLINE PRODUCTION
AND CONSUMPTION BY STATE
1974
(thousands of barrels)

	Gasoline Production	Gasoline Consumption		Gasoline Production	Gasoline Consumption
Alabama	528	44,349	Missouri	(4)	62,586
Alaska	(2)	3,883	Montana	27,133	10,667
Arizona	--	27,328	Nebraska	(4)	20,674
Arkansas	7,443	27,433	Nevada	(2)	9,110
California	266,529	235,428	New Hampshire	--	9,299
Colorado	8,420	30,999	New Jersey	90,024	75,588
Connecticut	--	31,602	New Mexico	9,820	16,275
Delaware	(3)	7,059	New York	14,749	142,806
District of Columbia	--	5,729	North Carolina	(6)	67,150
Florida	--	100,124	North Dakota	13,678	9,793
Georgia	(3)	65,229	Ohio	117,662	119,193
Hawaii	2	6,615	Oklahoma	99,584	39,893
Idaho	--	10,900	Oregon	--	28,278
Illinois	216,355	199,637	Pennsylvania	138,363	114,616
Indian	80,022	65,216	Rhode Island	--	8,851
Iowa	--	39,215	South Carolina	--	34,682
Kansas	100,613	31,646	South Dakota	--	10,868
Kentucky	29,197	39,919	Tennessee	(5)	51,948
Louisiana	281,788	41,818	Texas	609,897	169,030
Maine	--	12,382	Utah	21,331	14,677
Maryland	--	42,606	Vermont	--	5,603
Massachusetts	--	54,689	Virginia	13,170	58,130
Michigan	19,543	108,694	Washington	60,086	39,689
Minnesota	34,959	48,431	West Virginia	(6)	18,248
Mississippi	49,911	28,461	Wisconsin	(7)	51,084
			Wyoming	25,578	7,011
			Total	2,336,383	2,425,137

[1]Source: Mineral Yearbook, 1974; Bureau of Mines, U.S. Department of the Interior, p. 1008.
[2]Alaska, Hawaii, and Nevada production included with California.
[3]Delaware and Georgia included with Pennsylvania
[4]Nebraska and Missouri included with Kansas
[5]Tennessee included with Kentucky.
[6]North Carolina and West Virginia included with Virginia.
[7]Wisconsin included with North Dakota.

This higher yield of gasoline results in the U.S. importing a very low percent of its gasoline requirements but much higher percent of residual oils and other refined products. As an example, in 1974 the United States imported 60 percent of its residual fuel oil requirements.

REFINED PETROLEUM PRODUCTS MARKETS

The demand for refined petroleum products is derived primarily by the demand for energy although a portion of the demand comes from the petrochemical sector. The demand for energy in turn is a function of population, standard of living, weather conditions, and industrial requirements. The U.S. also exports refined petroleum products and petrochemicals which adds to the total demand.

The consumption mix of refined petroleum products depends on the geographic area of the country and the type of industries located in the area. For example, in the Northeast several electricity generating plants were converted from coal to oil. These plants consume residual fuel oil. Residual fuel oil is also used in heating large buildings and for marine shipping. This resulted in PAD (Petroleum Administration for Defense) District I, which includes the East Coast states from Florida to Maine, consuming 68.6 percent of the residual fuel oil used in the U.S. The percentage for other grades were, gasoline 34.9 percent, kerosine 41.6 percent, distillate 46.3 percent, and jet fuel 37.8 percent.

All refineries produce residual oils; therefore, a state in the midwest which has refining capacity roughly equal to its local demand for gasoline, may be producing twice its

local requirement for residual fuel oil. These imbalances result in substantial interstate shipments of refined products.

Exhibit VIII-3 delineates the states included in the Petroleum Administration for Defense districts. Exhibits VIII-4, 5, and 6 compare the production by district of the major refined products, the demand for the products by district and the interdistrict shipments. All figures in these exhibits are in thousands of barrels per day.

PETROLEUM PRODUCTS TRANSPORTATION

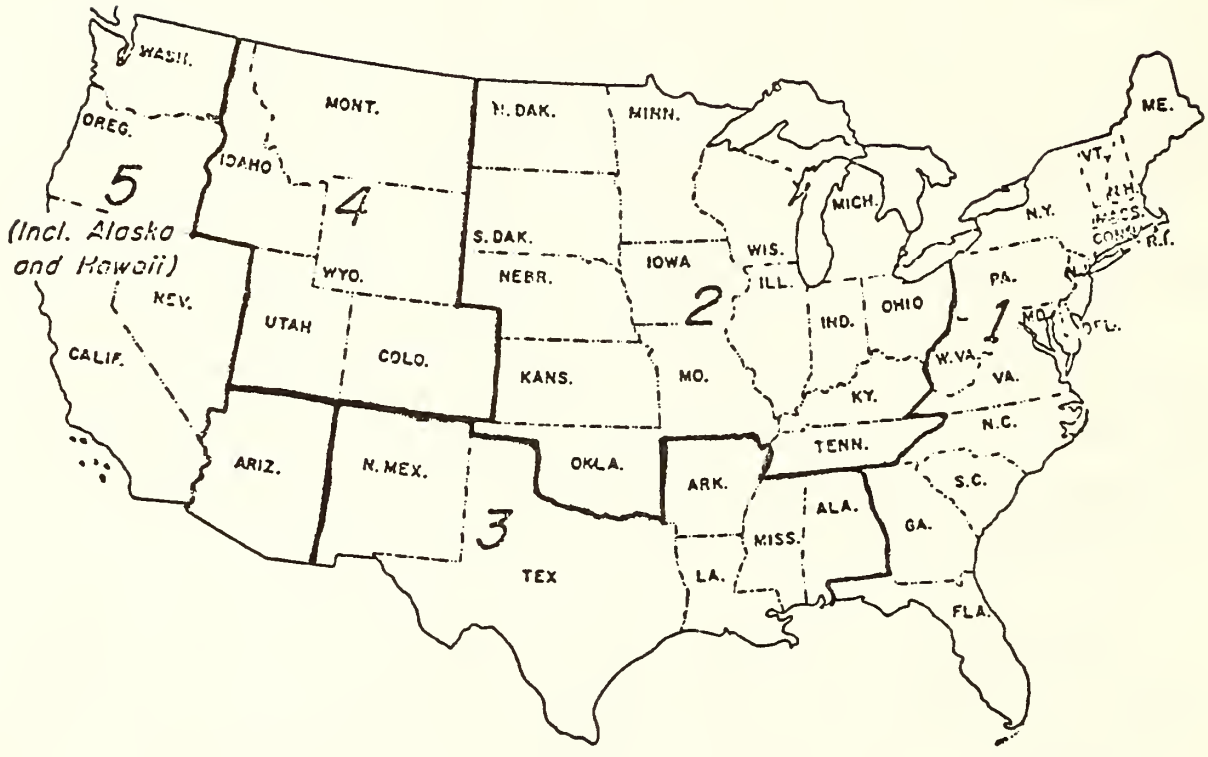
Most of the refined products are transported in a liquid bulk form. Asphalt is moved in a semi-dry form. The natural gases are moved in both gaseous and liquefied form and both forms require highly specialized equipment for transporting and handling.

Petroleum products are moved in single skinned tank barges. These barges are normally compartmented for product segregation. Some of these barges are equipped with heating coils, especially if they are designed for the carriage of heavy residual fuels with a high viscosity.

Pipelines which provided the major transportation means for crude oil deliveries to refineries are somewhat less important in the transportation of refined petroleum products. Refined products move in smaller volumes to many widely dispersed geographic locations and consequently their movements require a more flexible transportation system.

Exhibit VIII-3

PETROLEUM ADMINISTRATION FOR DEFENSE (PAD) DISTRICTS



Source: U.S. Department of the Interior, Bureau of Mines, Minerals Industry Surveys, Year 1975.

Exhibit VIII-4

PRODUCTION OF REFINED PRODUCTS BY PAD DISTRICT*
(thousands of barrels per day)

Product	PAD District I	II	III	IV	V	Total U.S.
Gasoline**	668	1,832	2,262	193	852	5,807
Jet Fuel	44	169	399	25	234	871
Kerosine	14	38	89	3	8	152
Distillate Fuel Oil	332	780	1,183	127	231	2,653
Residual Fuel Oil	187	192	448	36	373	1,236
Lubricants	26	23	90	1	14	154
Others	251	511	932	59	311	2,064
Total	1,522	3,545	5,403	444	2,023	12,937

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Industry Surveys, Year 1975.

*Refinery output only. Does not include natural gas liquid products.

**Includes aviation gasoline.

Exhibit VIII-5

1975 DEMAND FOR REFINED PRODUCTS BY PAD DISTRICT

(thousands of barrels per day)

Product	PAD District I	II	III	IV	V	Total U.S.
Gasoline	2,223	2,295	1,000	214	982	6,714
Jet Fuel	377	188	116	30	290	1,001
Kerosine	67	45	36	3	8	159
Distillate Fuel Oil	1,271	873	333	109	263	2,849
Residual Fuel Oil	1,460	260	281	37	394	2,432
Lubricants	55	31	36	2	14	138
Others	458	864	1,327	89	260	2,998
Total	5,911	4,556	3,129	484	2,211	16,291

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Industry Surveys, Year 1975.

Exhibit VII-6

INTERDISTRICT RECEIPTS OF PETROLEUM PRODUCTS

(thousands of barrels per day)

Product/Receiving District	From I	From II	From III	From IV	From V
Gasoline					
District I	-	31	1,485	-	-
District II	134	-	244	14	-
District III	-	52	-	-	-
District IV	-	12	12	-	10
District V	-	-	42	37	-
Distillate Fuel Oil					
District I	-	3	799	-	-
District II	37	-	63	10	-
District III	-	14	-	-	1
District IV	-	1	2	-	4
District V	-	-	13	16	-
Residual Fuel Oil					
District I	-	-	150	-	-
District II	-	-	32	-	-
District III	-	-	-	-	2
District IV	-	-	-	-	-
District V	-	-	7	-	-
All Other Products					
District I	-	52	439	-	1
District II	5	-	288	2	-
District III	-	13	-	9	-
District IV	-	-	13	-	5
District V	-	-	11	11	-
Total Product Transfers					
District I	-	86	2,873	-	1
District II	176	-	627	26	-
District III	-	79	-	9	3
District IV	-	13	27	-	19
District V	-	-	73	64	-

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Industry Surveys, Year 1975

PETROLEUM PRODUCTS GROUP MOVEMENTS

In 1976 the Petroleum Products group represented 19.7 percent of the total tonnage moved in the inland waterways of the Mid-America region. This makes the group second only to the Coal Products group in terms of total tons moved.

Exhibit VIII-7 shows petroleum products movements by state for 1976. It is apparent from the data in this table, that the movements of petroleum products occur in all areas of the Mid-America region, unlike the crude oil movements which are concentrated on the lower Mississippi River.

Exhibit VIII-8 shows the total movements of petroleum products for the years 1969-1976. Movements of petroleum products have been increasing at a compounded annual rate of 3.95 percent.

Exhibit VIII-7

PETROLEUM PRODUCTS MOVEMENTS BY STATES

1976

(short tons)

	Inbound	Outbound	Intrastate
Alabama	3,216,800	1,757,814	346,513
Arkansas	1,378,097	1,229,082	71,146
Illinois	4,634,046	5,522,957	2,405,702
Indiana	688,638	3,270,801	37,668
Iowa	895,583	7,296	0
Kansas	0	0	0
Kentucky	5,675,388	1,029,537	262,475
Louisiana	9,136,004	26,773,486	9,891,834
Minnesota	361,028	378,748	932,060
Mississippi	3,776,795	8,495,456	434,230
Missouri	2,333,247	1,223,822	369,837
Nebraska	0	0	0
Ohio	3,545,264	1,680,462	339,226
Oklahoma	0	585,696	0
Pennsylvania	3,740,807	505,892	147,522
Tennessee	5,898,977	471,599	284,202
West Virginia	2,573,024	3,481,155	509,330
Wisconsin	134,358	0	0
Total	47,988,056	56,411,125	16,031,745

Source: Temple, Barker and Sloane, Inc.

Exhibit VIII-8

PETROLEUM PRODUCTS GROUP MOVEMENTS

1969-1976

(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	36,512,832	45,912,289	9,354,091	91,779,212
1970	38,890,586	47,677,298	9,291,426	95,859,310
1971	41,930,942	49,708,930	9,809,171	101,449,043
1972	43,384,455	51,240,266	10,000,851	104,625,572
1973	45,334,167	47,878,386	10,982,010	104,194,563
1974	46,532,611	49,925,447	12,724,189	109,182,247
1975	44,960,226	53,993,075	12,418,385	111,371,686
1976	47,988,056	56,411,125	16,031,745	120,430,926

Compounded annual growth rate = 3.95%

Source: Temple, Barker and Sloane, Inc.

IX. COMMODITY GROUP 7
INDUSTRIAL CHEMICALS

The industrial chemicals commodity group includes the following CCSS classifications:

2810 Sodium Hydroxide (Caustic Soda)

2811 Crude Products from Coal Tar, Petroleum, and Natural Gas, except Benzene and Toluene

2812 Dyes, Organic Pigments, Dyeing and Tanning Materials

2813 Alcohols

2814 Sulphume Acid

2815 Boric Acid

2816 Radioactive and Associated Materials, including Waste

2817 Benzene and Toluene, Crude and Commercially Pure

2818 Sulfuric Acid

2819 Basic Chemicals and Basic Chemical Products, NEC

2821 Plastic Materials, Regenerated Cellulose and Synthetic Resins, including Film, Sheeting and Laminates

2823 Synthetic (man-made) Fiber

2851 Paints, Varnishes, Lacquers, Enamels and Allied Products

2861 Gum and Wood Chemicals

2876 Insecticides, Fungicides, Pesticides, and Disinfectants

2891 Miscellaneous Chemical Products

1493 Sulfur, Liquid

The industrial chemicals group was formulated as such to reflect the specialized handling requirements of the commodities; and furthermore, because of each commodity's direct relationship to the Chemical Processing Industry (SIC 28).

Only three of the CCSS classifications included in this group specify a single commodity. Those three are sulfuric acid, benzene and toluene, and sodium hydroxide. All other CCSS classifications could inlcude several different chemical compounds and mixtures. This generality is necessary as the number of chemicals and compounds is in the thousands and is growing.

However, the generalization of groups makes exact statistics on individual commodities difficult to obtain. This problem is compounded by the fact that many chemicals are referred to by several different names. An example of this problem is sodium hydroxide which may also be referred to as lye or caustic soda.

Exhibit IX-1 shows the percentage composition of the Industrial Chemicals Group and the tons of each commodity that moved on the inland waterways of the Mid-America Region in 1976.

INDUSTRIAL CHEMICAL PRODUCTION

In recent years the Chemical Process Industries have located more and more plants in the south. Texas and Louisiana have fared best in the states' efforts to attract the industry. These states offer easy access to natural gas, petroleum and waterborne transportation. Chemical plant

Exhibit IX-1

PERCENTAGE COMPOSITION OF
INDUSTRIAL CHEMICALS GROUP

		Short Tons*	Percent of Total*
1493	Sulfur, Liquid	2,952,448	11.5
2810	Sodium Hydroxide	3,157,835	12.3
2811	Cool Tar Products	2,156,511	8.4
2812	Dyes, Pigments, etc.	--	--
2813	Alcohols	2,165,223	8.2
2814	Sulphume Acide	--	--
2815	Boric Acid	--	--
2817	Benzene and Toluene	1,925,509	7.5
2818	Sulfuric Acid	1,309,346	5.1
2819	Basic Chemicals, NEC	11,630,078	45.3
2821	Plastic Materials	--	--
2823	Synthetic Fiber	--	--
2851	Paints, Varnishes, etc.	--	--
2861	Gum and Wood Chemicals	--	--
2876	Insecticides, Fungicides, etc.	--	--
2891	Miscellaneous Chemical Products	385,102	1.5
Total		25,673,132	100.0%

*Percentages obtained from Waterborne Commerce of the United States, 1976 Part 2, page 140. The tonnage figures were adjusted to reflect the boundaries of the 17 state Mid-America region.

expenditures in the U.S. for 1978 are expected to maintain the $7 billion level of 1977, with Texas and Louisiana receiving about one billion. The Southern region of Texas, Oklahoma, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi and Alabam are expected to receive almost 50 percent of the total expenditures for expansion.[1]

Exhibits IX-2 through IX-4 show the concentration of the chemical industry. These concentrations form the pattern of chemical product movements as will be discussed under Industrial Chemical Markets.

INDUSTRIAL CHEMICAL MARKETS

Virtually no industrial chemicals are used as building blocks for other chemicals or as inputs to materials to be used in the production of consumer goods. As such, the biggest consumer of industrial chemicals is the chemical industry itself.

This results in patterns of chemical movements from one area of chemical production to another. Large volumes of chemicals move from the lower Mississippi River production areas up to the Illinois Waterway and Ohio River system. The other major pattern of movements occurs from U.S. Gulf ports to East Coast ports in coastwise trade.

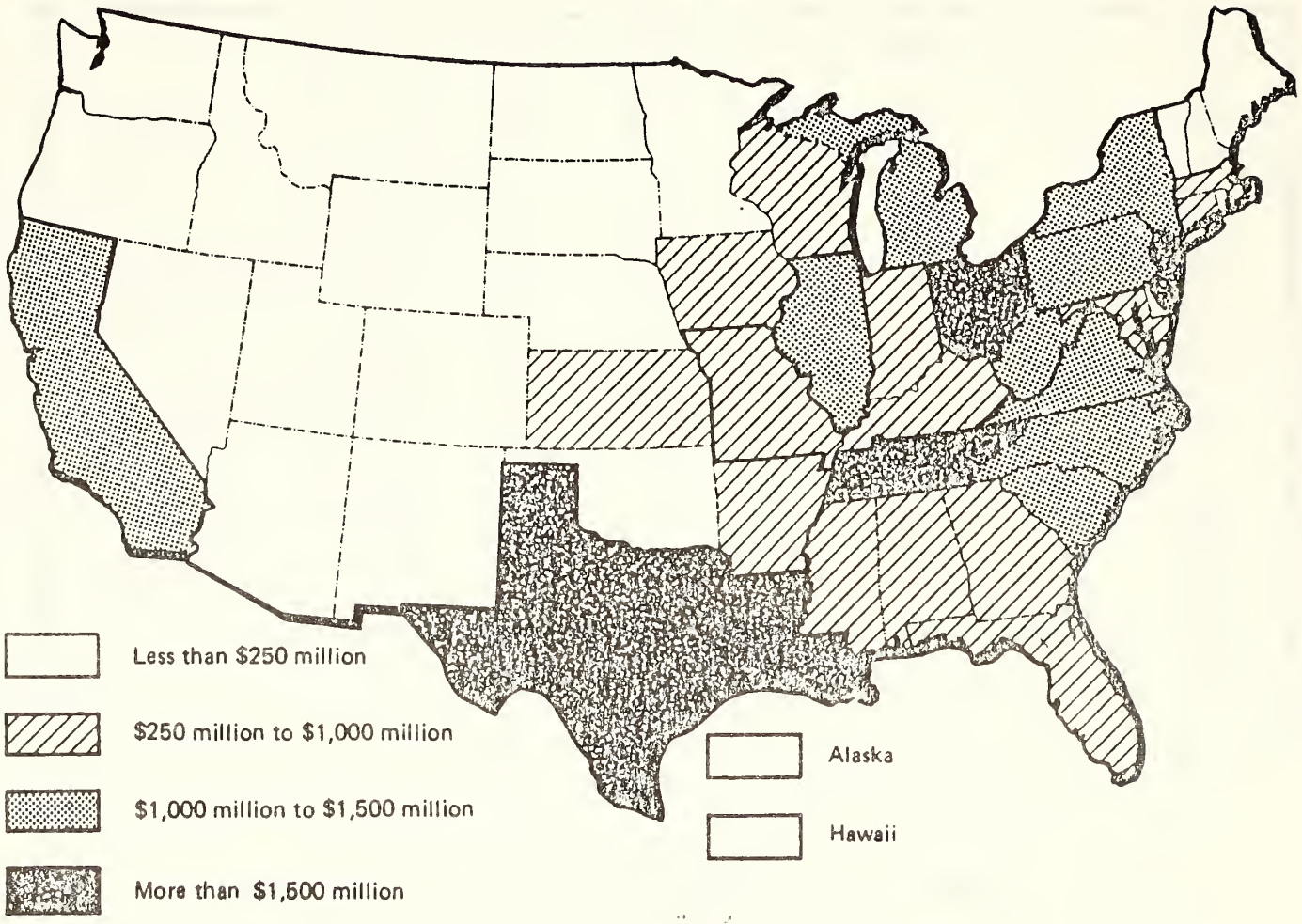
Export markets play a large role in the U.S. chemical industry. In 1976 exports represented 9.8 percent of the total industry sales compared to the 1966 figure of 6.7 percent.

[1]Chemical Week, December 14, 1977, p. 49-50.

Exhibit IX-2

GEOGRAPHICAL DISTRIBUTION OF U.S. CHEMICAL INDUSTRY

1971



Source: *Annual Survey of Manufactures.*

Exhibit IX-3

GEOGRAPHICAL DISTRIBUTION OF THE CHEMICAL INDUSTRY

1971

Percentage of Total

	Dollar shipments						
	Basic chemicals	Polymers	Agricultural chemicals-a	Other chemicals-b	All chemicals	All manufacturing	Personal income
Northeast							
New England	1.6%	4.8%	1.0%	4.4%	2.8%	5.5%	6.2%
Middle Atlant	18.2	12.1	7.9	24.7	16.6	19.2	20.6
	19.8	16.9	8.9	29.1	19.4	24.7	26.8
North Central							
East North Central	14.7	11.0	16.8	24.8	15.2	28.3	20.6
West North Central	4.3	1.9	9.0	11.3	5.0	7.7	7.6
	19.0	12.9	25.8	36.1	20.2	36.0	28.2
South							
South Atlantic	13.9	36.3	28.1	11.3	20.9	12.7	14.0
East South Central	10.6	16.7	16.0	6.4	12.2	5.9	4.8
West South Central	30.6	13.6	9.0	7.8	20.9	7.8	8.1
	55.1	66.6	53.1	25.5	54.0	26.4	26.9
West							
Mountain	1.6	0.2	4.3	0.9	1.4	2.2	3.8
Pacific	4.5	3.4	7.9	8.4	5.0	10.7	14.3
	6.1	3.6	12.2	9.3	6.4	12.9	18.1
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

a—Excludes nitrogen compounds and potash except when mixed with phosphates.

b—Includes gum and wood chemicals, adhesives, explosives, carbon black, surfactants, medicinals, and other chemicals.

Sources: *Annual Survey of Manufactures; Statistical Abstract;* and estimates by C. H. Kline & Co.

Source: Kline Guide to the Chemical Industry, page 48.

Exhibit IX-4

INDUSTRIAL CHEMICAL PRODUCTION BY
BUREAU OF THE CENSUS DIVISION*

Division	Thousands of Short Tons	% of U.S. Total
New England	**	**
Middle Atlantic	10,883	13.7
East North Central	13,499	17.0
West North Central	1,007	1.2
South Atlantic	7,527	9.5
East South Central	5,606	7.1
West South Central	34,409	43.4
Pacific	3,000	3.8
Total U.S.	79,278	100.0

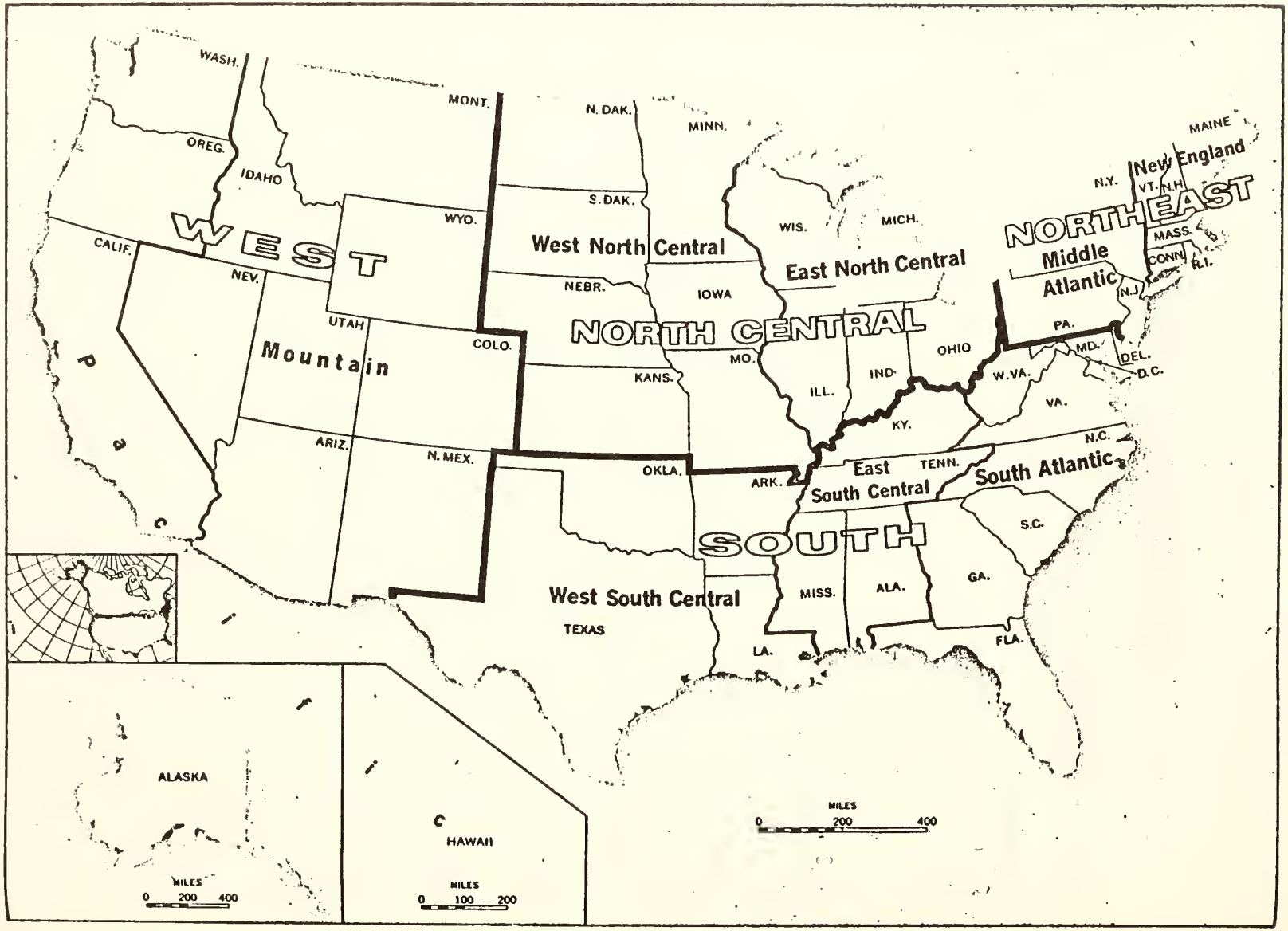
*See Figure IX-1 on following page for delineation of Divisons.

**Statistics not available.

Source: U.S. Department of Commerce, 1972 Census of Transportation, Vol. III, Part 1.

Figure IX-1

Regions and Geographic Divisions of the United States



Source: U.S. Department of Commerce, 1972 Census of Ttransportation, Volume III, Part 1.

TRANSPORTATION OF INDUSTRIAL CHEMICALS

Industrial chemicals are moved in all forms although waterborne movements are normally either in liquid or gaseous form.

Packaging and volume of shipments are a function of the receivers capabilities to accept a given type of shipment and store it. Most chemical producers offer their products for shipment in a variety of volumes which may range from 50 pound boxes to hopper railcar lots or 50 gallon drums to 8,000 gallon tank car lots depending on the form of the product.

Packaging and transporting of chemicals is further complicated by the inherent characteristics of the products. Some chemicals such as chlorine and ammonia are in a gaseous state at normal temperatures and must be pressurized to obtain a liquid state for ease of handling and more efficient transportation and storage. Other chemicals, such as phenol are liquid at normal temperatures but require heating for pumping in cold temperatures. Finally, chemicals such as bromine and hydroflouric acid are corrosive and need specially lined containers.

These factors all complicate the handling and transportation of chemicals and result in the Department of Transportation classifying most chemicals as either hazardous or dangerous due to their flammable, combustible, corrosive or poisonous characteristics.

Safe and efficient handling of such materials often requires the use of specialized equipment. Many of the large chemical producers operate their own specialized chemical barges, railcars and trucks. However, in 1975

less than 20 percent of the chemicals moved on the inland waterways were moved by private carriers. Most waterborne transportation of chemicals where specialized equipment is required is done on long term contract basis.

Like the transportation equipment, the terminal facilities that handle chemical products are specialized. The majority of terminals are privately owned and are located at the site of the production or consuming facility.

The inland waterways have attracted many chemical producers to their banks in recent years; however, the waterways by no means have an exclusive hold on chemical transportation. Many chemical users are not located on the waterways or purchase in such small volume that barge load shipments would not be feasible. In such cases railroads or trucks are used. Pipelines do not play a role in chemical transportation primarily because the volume flows of any one product between two points is not large enough to justify the capital investment.

In 1976, 25.7 million tons (Exhibit IX-1) of chemicals and related products moved on the waterways in internal traffic. This represented 8 percent of the total tonnage moving in internal traffic and about 12 percent of the total ton-miles with the average haul being 721 miles per ton.

Exhibit IX-5 shows the shipments of the Industrial Chemicals Group by state in 1976. Of particular interest is the large movement in Louisiana. Nearly three quarters of the shipments of industrial chemicals originate in Louisiana.

The aggregate movements of the Industrial Chemicals Group for 1969-1976 are displayed in Exhibit IX-6. The total shipments figure has remained relatively stable over the period.

Exhibit IX-5

INDUSTRIAL CHEMICAL SHIPMENTS

1976

(short tons)

	Inbound	Outbound	Intrastate
Alabama	1,769,492	336,804	38,231
Arkansas	160,184	191,046	0
Illinois	2,674,471	629,762	151,923
Indiana	861,313	3,402	0
Iowa	94,268	58,936	0
Kansas	0	0	0
Kentucky	799,103	377,232	70,663
Louisiana	2,234,660	9,084,210	5,462,305
Minnesota	308,231	0	0
Mississippi	338,748	272,276	0
Missouri	876,284	328,363	11,890
Nebraska	14,445	0	0
Ohio	1,569,705	121,235	0
Oklahoma	2,051	44,972	0
Pennsylvania	631,054	505,892	251,786
Tennessee	764,535	43,024	3,940
West Virginia	1,385,262	594,039	623,123
Wisconsin	0	0	0
Total	14,483,806	12,591,193	6,613,861

Source: Temple, Barker & Sloane, Inc.

Exhibit IX-6

INDUSTRIAL CHEMICAL MOVEMENTS
1969-1976
(short tons)

	Inbound	Outbound	Intrastate	Total
1969	12,172,543	11,897,393	7,086,097	31,156,033
1970	13,542,332	12,945,001	7,481,076	33,968,409
1971	14,135,782	13,620,084	7,810,240	35,566,106
1972	15,022,607	14,337,179	8,213,602	37,573,388
1973	13,854,563	12,934,563	8,332,644	35,121,770
1974	15,513,004	13,223,809	8,701,786	37,438,599
1975	13,300,136	11,559,576	7,651,036	32,510,748
1976	14,483,806	12,591,193	6,613,861	33,688,860

Source: Temple, Barker & Sloane, Inc.

X. COMMODITY GROUP 8
AGRICULTURAL CHEMICALS/FERTILIZERS

This group contains the following Army Corps of Engineers classifications:

1471 Phosphate Rock
1479 Natural Fertilizer Materials, NEC
2871 Nitrogenous Chemical Fertilizers, except mixtures
2872 Potassic Chemical Fertilizers, except mixtures
2873 Phosphatic Chemical Fertilizers, except mixtures
2874 Phosphate Fertilizer and Material
2875 Ammonium Sulphates, All Grades
2879 Fertilizers and Fertilizer Materials, NEC

These commodities were grouped together due to their commonality as an input to the agricultural sector. They also have very similar handling characteristics and consequently can be handled in the same type of terminals.

Exhibit X-1 shows the percentage composition of the agricultural fertilizers and chemicals group and the tonnage of each commodity that moved in the study area in 1976.

Identification and Overview of Agricultural Chemicals/Fertilizers

This section focuses on each individual type of fertilizer and delineates their producing and consuming areas. It also discusses phosphate rock, a major input to

Exhibit X-1

PERCENTAGE COMPOSITION OF THE
AGRICULTURAL CHEMICALS AND FERTILIZERS GROUP

Commodity	Short Tons*	Percent*
Phosphate Rock	7,563,520	57.4
Natural Fertilizer	0	0
Nitrogenous Chemical Fertilizer	2,499,395	19.0
Potassic Chemical Fertilizer	171,401	1.3
Insecticides, Fungicides, Pesticides, Disinfectant	2,284	0.0
Fertilizer Materials, NEC	2,553,957	19.4
Phosphatic Chemical Fertilizers	385,082	2.9
Total	13,175,639	100.0

*May not add due to rounding. Percentages obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnage figures were adjusted to reflect the boundaries of the 17 state Mid-America region.

the agricultural fertilizer industry. Exhibit X-2 shows the 25 largest commercial fertilizer consuming states. These states account for 87 percent of all U.S. fertilizer consumption.

Nitrogenous Fertilizers

Nitrogen is one of three nutrients necessary to sustain plant life. Agricultural acreage can become depleted of nitrogen over a period of time. To preclude such depletion, nitrogenous fertilizers are used to replenish the nitrogen in the soil.

For nitrogen to be returned to the soil, it must be in a fixed form. Ammonia (NH_3) is the primary form from which fertilizers are manufactured. Ammonia is generated by reacting hydrogen with atmospheric nitrogen in what is known as the Haber Bosch process.

Most modern ammonia producing plants use natural gas as their source of hydrogen. Nitrogen is available in virtually unlimited quantities from the atmosphere. Consequently, ammonia production facilities tend to be concentrated in areas near natural gas sources, although with interstate natural gas pipelines this is not essential. This has resulted in recently constructed plants being located in Louisiana and Texas.

In 1974 slightly over 13 million short tons of contained nitrogen were produced in the United States. Of this amount, 74 percent or about 9.6 million tons was used in the production of fertilizers. Anhydrous ammonia which accounted

Exhibit X-2

CONSUMPTION OF COMMERCIAL FERTILIZER BY STATE

1975*

(Short Tons)

State	Tons	Nitrogen (N)	Phosphoric Oxide (P_2O_5)	Potash (K_2O)
California	3,956,097	556,325	164,961	73,616
Illinois	3,414,483	817,847	422,666	531,543
Iowa	2,999,785	746,919	424,512	442,826
Texas	2,215,052	624,715	223,963	92,047
Georgia	2,022,670	265,397	131,725	209,870
Minnesota	1,926,786	450,318	290,000	329,131
North Carolina	1,882,483	220,056	143,577	189,686
Indiana	1,881,538	326,306	218,695	318,200
Ohio	1,736,802	281,708	246,935	281,549
Florida	1,675,571	187,446	87,473	210,668
Kansas	1,464,107	567,959	173,840	45,713
Missouri	1,341,121	304,782	152,834	185,209
Nebraska	1,227,330	491,955	110,851	44,226
Wisconsin	947,182	133,414	130,781	236,960
Alabama	933,458	149,718	92,181	99,702
Kentucky	880,957	124,782	104,459	117,006
Michigan	849,136	136,697	114,514	146,337
Virginia	808,471	90,774	68,878	83,687
South Carolina	798,780	89,567	60,137	92,183
Mississippi	762,832	187,075	68,213	62,348
Tennessee	691,636	100,795	79,632	88,299
Oklahoma	652,411	190,687	88,822	27,954
Pennsylvania	622,261	78,629	77,170	72,217
New York	586,386	88,553	69,759	70,945
Arkansas	577,659	127,735	56,550	65,975
All Others**	5,653,036	1,267,586	707,851	334,735
Total U.S. Consumption	42,508,030	8,607,740	4,510,979	4,452,632

*Source: Agricultural Statistics 1976, U.S. Department of Agriculture.

**Includes Puerto Rico.

for 99 percent of the contained nitrogen production was produced in 37 states, however, the states of Louisiana, Texas, and California produced 42 percent of the total.[1]

The fertilizers produced from nitrogen include: urea, ammonia sulfate, ammonium nitrate, sodium nitrate and diammonium phosphate (discussed in phosphatic fertilizers). Nitrogenous fertilizer production facilities tend to be located near the facilities producing ammonia. An exception to this is ammonium sulfate which is produced as a byproduct of the coke industry.

Exhibit X-2 shows the consumption of commercial fertilizers by state and the nitrogen content of that fertilizer.

Potassic Chemical Fertilizer

Potassic chemical fertilizers commonly referred to as potash are produced from potassium salts. Commercially recoverable deposits of potassium salts in the United States is limited. These deposits are located primarily around Carlsbad, New Mexico which accounts for 82 percent of domestic production as of 1974. The balance of the potassium salts are mined in Utah and California.

Ninety-five percent of the potash production in the U.S. is consumed for agricultural fertilizers. The United States produced 42 percent of its domestic potash requirements in 1974, with the balance being met by imports, mainly from Canada. Exhibit X-2 shows potassic content consumption by state.

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[1]Source: Minerals Yearbook 1974, Bureau of Mines, U.S. Department of the Interior.

Less than 200,000 tons of potassic chemical fertilizers moved in internal traffic in 1976. Although the major consuming states in the Midwest are all accessible by the waterways, the production states in the Southwest are not; therefore, railroads are used as the prime mover from production area to market.

Phosphate Rock

Phosphate rock is a primary input to phosphatic chemical fertilizers. In 1974 about 82 percent of domestic consumption of phosphate rock was used in the production of fertilizers.

Phosphate rock is mined from surface mines. Some mined rock is acceptable for marketing or use as it is mined while most is washed to remove some of the impurities.

The major phosphate rock producing states are Florida, North Carolina and Tennessee. Some phosphate rock is also produced in the Western states. Exhibit X-3 shows the production by area.

The fertilizer industry has concentrated most of its production capacity of phosphatic chemical fertilizers near sources of phosphate rock. However, their are phosphatic fertilizer plants located in Texas and in Louisiana which use Florida phosphate rock. This accounts for most of the 8 million tons of coastwise movement of phosphate rock in 1976.

Phosphate rock accounts for over 60 percent of the tonnage of the Agricultural Chemicals and Fertilizer group. The major portion of the phosphate rock movements originate in

Exhibit X-3

U.S. PRODUCTION OF PHOSPHATE ROCK
(thousands of short tons)

Florida/North Carolina	36,980
Western States*	6,295
Tennessee	2,411
Total	45,686

*Includes Idaho, Missouri, Montana, Utah and Wyoming.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1974.

Florida and terminate in Louisiana on the Mississippi River. Some phosphate rock is moved up the Mississippi River to the Illinois Waterway where phosphoric acid and fertilizers are produced at Joliet, Illinois.

Phosphatic Chemical Fertilizers

The two main types of phosphatic fertilizers are superphosphate and ammonium phosphate. Superphosphates are produced by acidulating natural phosphate material with sulfuric acid or a mixture of sulfuric acid and phosphoric acid. Ammonium phosphates are produced by ammoniating phosphoric acid.

Ammonium phosphates account for over 60 percent of the phosphatic fertilizer used in the United States. Ammonium phosphate plants are located in eleven states, however, over 73 percent of the production capacity is located in Florida (50.3 percent) and Louisiana (23.2 percent)[1]. Phosphoric acid which is a major input to ammonium phosphate production is produced in ten states, but like ammonium phosphate, over 75 percent of the productive capacity is located in Florida and Louisiana near the ammonium phosphate plants.

The concentrated superphosphates are also produced near the source of phosphate rock. As a result, 11 of the 17 total superphosphate producing plants are located in Florida, representing 74.5 percent of the total productive capacity.[2] Other plants are located in Idaho (2) and North Carolina, Utah, Missouri, and Mississippi.

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[1] Fertilizer Trends 1976, National Fertilizer Development Center, March 1977.

[2] Ibid.

Exhibit X-2 shows phosphoric oxide content of the commercial fertilizers consumed in the United States in 1975. In addition to the 4.5 million tons of phosphoric oxide content used domestically, the United States exported slightly over one million tons of phosphoric fertilizers in 1975.

Fertilizer Transportation and Handling Characteristics

Fertilizers are normally transported in covered hopper barges. They are moved in a dry bulk form, and do not require any special attention or care in transit. The fertilizers in this group are all classified as harmless fertilizers.

Fertilizers are loaded by conveyor belt loading facilities and are normally discharged with grabs or buckets.

Agricultural Chemicals and Fertilizers Group Movements

Exhibit X-4 shows the waterborne movements by state. From this exhibit the general pattern of movements is obvious. When the 6.2 million tons of phosphate rock being moved from Florida to Louisiana is factored out, Louisiana remains as the only true net outbound shipper of fertilizers. All other states with the exception of Arkansas, are net receivers of fertilizers. This results in upbound movements from Louisiana to the Upper Mississippi and Ohio Rivers. Illinois and Minnesota are the two largest recipients of fertilizers in the Northern Mid-America Region.

Exhibit X-5 shows the movements of fertilizers from 1969 to 1976 which have been growing at an annual compounded rate of 9.2 percent. As a group, the agriculture chemicals and fertilizers represent 3.0 percent of the total tonnage moved on the inland waterway system.

Exhibit X-4

AGRICULTURAL FERTILIZERS AND CHEMICALS GROUP WATERBORNE MOVEMENTS

1976

(Short Tons)

State	Inbound	Outbound	Intrastate
Alabama	183,215	94,054	10,269
Arkansas	221,451	312,080	0
Illinois	1,919,883	39,450	10,974
Indiana	30,116	7,354	0
Iowa	781,780	1,520	0
Kansas	2,200	0	0
Kentucky	204,379	51,417	3,278
Louisiana	6,481,659	4,125,534	120,509
Minnesota	588,336	17,642	0
Mississippi	775,479	361,930	53,439
Missouri	413,784	300,545	14,379
Nebraska	98,518	138,491	2,334
Ohio	419,219	4,425	0
Oklahoma	59,242	0	0
Pennsylvania	29,659	6,027	0
Tennessee	105,134	49,119	0
West Virginia	2,713	22,421	0
Wisconsin	6,055	0	0
Total	12,320,622	5,532,009	237,700

Source: Temple, Barker & Sloane, Inc.

EXHIBIT X-5

AGRICULTURAL FERTILIZERS AND
CHEMICALS GROUP SHIPMENTS

1969-1976

(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	6,299,248	3,028,712	453,518	9,781,478
1970	7,632,809	3,828,411	551,522	12,012,742
1971	9,674,491	4,293,924	858,276	14,826,691
1972	10,948,087	4,468,341	1,489,192	16,905,620
1973	10,729,197	4,297,164	1,565,077	16,591,438
1974	10,644,980	4,614,515	1,601,000	16,860,495
1975	12,081,782	5,278,269	879,706	18,239,757
1976	12,320,622	5,532,009	237,700	18,090,331

Compounded Growth Rate = 9.2 percent.

Source: Temple, Barker & Sloane, Inc.

XI. COMMODITY GROUP 9
MILLED GRAIN AND AGRICULTURAL PRODUCTS, NEC

This group includes the following Army Corps of Engineers classifications:

0101	Cotton, Raw
0121	Tobacco
0122	Hay and Fodder
0129	Field Crops, NEC
0131	Fresh Fruits and Tree Nuts, except Bananas and Plantains
0132	Bananas and Plantains
0133	Coffee, Green and Roasted
0134	Cocoa Beans
0141	Fresh and Frozen Vegetables
0151	Live Animals (Livestock)
0161	Animals and Animal Products, NEC
0191	Miscellaneous Farm Products
0911	Fresh Fish, except Shellfish
0912	Shellfish, except Prepared or Preserved
0913	Menhaden
2041	Wheat Flour and Semolina
2042	Prepared Animal Feeds
2049	Grain Mill Products, NEC

Exhibit XI-1 shows the tonnage of each commodity moved in the Mid-America Region in 1976 and the percentage that tonnage represented of the total commodity group.

Exhibit XI-1

BREAKDOWN OF MILLED GRAIN AND
AGRICULTURAL PRODUCTS GROUP BY COMMODITY TONS AND PERCENT

Commodity	Short Tons*	Percent*
Cotton	1,208	--
Tobacco	0	0
Hay and Fodder	15,490	.2
Field Crops, NEC	9,465	.1
Fruits, Nuts	7,326	.1
Bananas, Plaintains	0	0
Coffee	0	0
Cocoa Beans	0	0
Vegetables	0	0
Live Animals	0	0
Animal Products, NEC	0	0
Misc. Farm Products	0	0
Fresh Fish	1,264	--
Shellfish	7,830	.1
Menhaden	0	0
Wheat Flour and Semolina	206,777	2.8
Prepared Animal Feeds	576,022	7.8
Grain Mill Products, NEC	6,565,170	88.9
Total	7,384,894	100.0

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

These commodities were grouped due to their common relationship to the agricultural sector. The handling characteristics vary substantially between commodities; however, generally the low volume commodities are handled as general cargo and the three largest commodities; flour, animal fields and grain mill products, nec.; are moved primarily in bulk, and consitute the majority of this commodity group.

MILLED GRAIN PRODUCTION

The milled grain industry has undergaone a rationalization since the 1930s. The number of mills has declined dramatically as the use of flour and other milled products in the home has declined, being replaced by store-bought products. This has resulted in movements of flour from mills to large food processors rather than to small retailers. It has also precipitated a shift from packaged milled products to bulk movements of milled products.

Similar trends exist in the prepared animal feeds segment of the industry. Small farms have been replaced by larger farms and feed lot operations. These larger operations have the capability to receive large volumes of feed in bulk; consequently, less and less feed is moved in bags.

In the grain mill products, NEC, classification, the major commodity is soybean meal. Soybeans are very rarely consumed in their natural form in this country. In 1974,

57.7 percent of the soybeans produced in this country were processed (crushed) domestically with 34.6 percent of the crop being exported in its natural state.[1] Soybeans, when crushed, produce soybean oil and soybean cake and meal. The main use of the meal is for cattle and poultry feed with the most of the balance being exported.

The soybean crushing plants are located in the main soybean growing states of Iowa, Illinois, Arkansas, Missouri, Mississippi and Tennessee. These plants tend to be located on waterways where the products are accessible to water transportation and the export market. Other crushing plants are located in areas inaccessible to the waterways; however, these plants are at a competitive disadvantage in vying for export sales.

As shown in Exhibit XI-2, the primary destination of grain mill products is the state of Louisiana. Soybean meal is received by barge at several of the large grain export elevators on the Mississippi River in the New Orleans area and transferred to ocean going vessels in the same manner that grain exports are handled. In 1974 the U.S. exported 4.3 million tons of soybean meal.

HANDLING CHARACTERISTICS OF MILLED GRAIN PRODUCTS

Flour and semolina are very fine and powdery in nature. These products are moved in compartmentalized barges as it is mandatory that they not come in contact

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[1] Agricultural Statistics 1976, USDA, Page 129.

Exhibit XI-2

MILLED GRAIN AND AGRICLUTURAL
PRODUCTS, NEC GROUP MOVEMENTS

1976

(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	164,881	258,396	9,675
Arkansas	5,827	706,034	0
Illinois	49,586	1,734,963	237
Indiana	600	31,765	0
Iowa	8,614	407,834	1,316
Kansas	0	1,169	0
Kentucky	1,477	182,980	0
Louisiana	6,021,541	248,731	727,328
Minnesota	8,237	370,896	0
Mississippi	18,532	197,834	74,425
Missouri	20,302	1,059,501	6,618
Nebraska	0	252,419	0
Ohio	41,406	86,917	0
Oklahoma	0	75,387	0
Pennsylvania	41,346	0	0
Tennessee	51,592	824,328	933
West Virginia	0	0	0
Wisconsin	0	0	0
Total	6,433,941	6,439,154	833,519

Source: Temple, Barker & Sloane, Inc.

with moisture. Due to its powdery nature flour is most efficiently handled with pneumatic equipment. Almost all large installations which handle flour are equipped with such equipment.

Prepared animal feeds are coarser in nature than flour; however, they still can be handled very effectively with pneumatic equipment and are less sensitive to contact with moisture.

Soybean meal is normally finer than prepared animal feeds. It tends to cake together into lumps if exposed to moisture, but is the least sensitive of the milled grains to contact with moisture and is normally moved in standard covered hopper barges. Water is often added to the meal prior to export shipment.

Exhibit XI-3 shows the tonnage of milled grain products moved from 1969-1976. This group has experienced a 16.8 percent compounded growth rate over this period, which is attributed partially to the trends of shipping these products in bulk versus in bags, and partially due to a rapid growth rate of the soybean industry in the United States. In 1976 the milled grain products group represented 1.7 percent of the total tonnage moved in the Mid-America region.

Exhibit XI-3

MILLED GRAINS AND AGRICULTURAL PRODUCTS, NEC GROUP SHIPMENTS

1969-1976

(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	1,973,767	2,076,987	573,289	4,624,043
1970	2,291,734	2,391,089	419,297	5,102,120
1971	2,551,166	2,695,706	529,874	5,776,746
1972	2,803,354	2,930,152	803,405	6,536,911
1973	2,775,000	2,913,900	844,772	6,533,672
1974	3,865,816	3,996,589	889,728	8,752,133
1975	4,440,864	4,554,511	793,762	9,789,137
1976	6,433,941	6,439,154	833,519	13,706,614

Compounded Annual Growth Rate 16.8 percent.

Source: Temple, Barker & Sloane, Inc.

XII. COMMODITY GROUP 10
LUMBER AND WOOD PRODUCTS

The Lumber and Wood Products Group consists of the following Army Corps of Engineers classifications.

0861	Forest Products, NEC
2411	Logs
2412	Rafted Logs
2413	Fuel Wood, Charcoal, and Wastes
2414	Timber, Posts, Poles, Pilings
2415	Pulpwood, Log
2416	Wood Chips, Stoves, Moldings, and Excelsior
2421	Lumber
2431	Veneer, Plywood, and Other Worked Wood
2611	Pulp

The commodities were grouped due to their common handling characteristics. Specialized equipment is normally used to handle logs, lumber and other forest products. This group has been matched with the MarAd's terminal classification for lumber and wood products.

Exhibit XII-1 shows the tons of each commodity moved in 1976 in the Mid-America Region and the percentage of the entire group those tons represent. It is apparent that only three commodities are moved in significant volume, i.e., logs; pulpwood, log; and pulp. The latter two commodities are linked directly with the paper industry, whereas the logs will be used in the production of lumber.

Exhibit XII-1

BREAKDOWN OF LUMBER AND WOOD
PRODUCTS GROUP BY COMMODITY
1976

Commodity	Short Tons*	Percent*
Forest Products, NEC	0	0
Logs	580,626	32.3
Rafted Logs	0	0
Fuel Wood, Charcoal Wastes	0	0
Timber, Posts, Poles, Pilings	8,988	.5
Pulpwood, Log	665,113	37.0
Wood Chips, Staves, Moldings and Excelsior	0	0
Lumber	115,047	6.4
Veneer, Plywood, Other Worked Wood	86,284	4.8
Pulp	341,544	19.0
Total	1,797,604	100.0%

*Numbers may not total due to rounding.
Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

PRODUCTION OF PULPWOOD, LOGS AND PULP

Woodpulp, because of its volume and relatively low value, is not transported long distances. Pulp and integrated pulp and paper plants tend to be located close to the source of pulpwood.

In recent years the production of pulp has become more and more concentrated in southern United States, where large amounts of softwood timber are available. In 1947, the South accounted for only 48 percent of the U.S. production of pulp. By 1973, this figure had grown to 65 percent (see Exhibit XII-2). This area does not, however, produce a comparable percentage of the primary products (paper and board). This gives rise to substantial movements of woodpulp.

Exhibit XII-3 shows the density of paper and board production throughout the United States. When compared to the density of woodpulp production also in Exhibit XII-3, the general pattern of pulp flows can be seen from states such as Alabama to Tennessee and Illinois.

LOGS

The production of lumber is less geographically concentrated than the pulp and paper industry; and, as such, the movements of logs cannot be described with generalizations about flows. Logs are not transported long distance due to their bulk and relatively low value.

Exhibit XII-2

GEOGRAPHIC DISTRIBUTION
OF THE PULP AND PAPER INDUSTRY 1973[1]

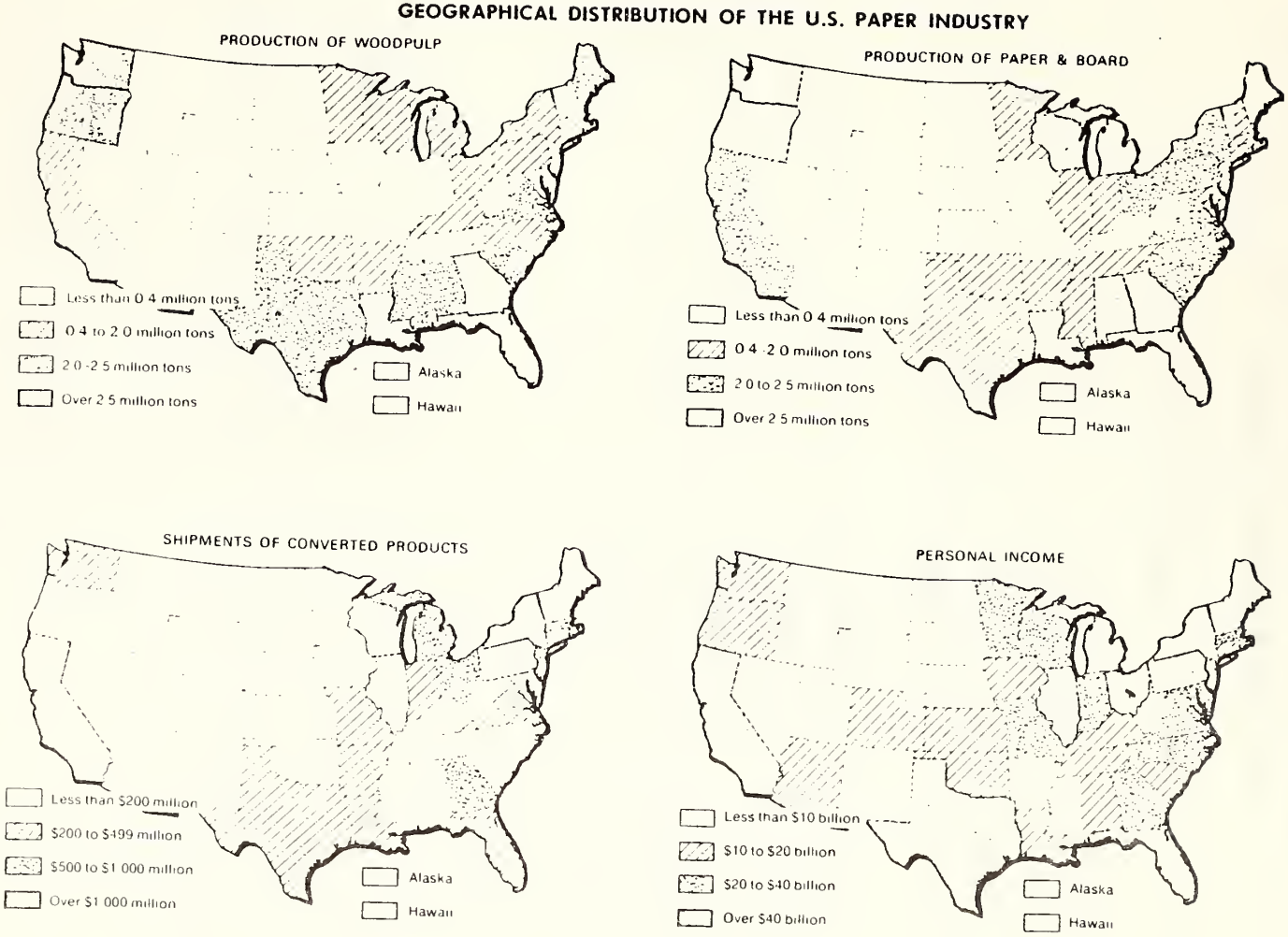
Percentage of total

	Woadpulp	Paper and baard	Converted praducts	Persanal incame
New England				
Massachusetts	*	1.4%	4.1%	2.9%
Maine	4.8%	4.6	0.9	0.4
Other	0.9	2.0	2.7	2.7
	5.7	8.0	7.7	6.0
Middle Atlantic				
New York	—	3.5	7.5	9.6
Pennsylvania	1.2	4.1	7.4	5.6
New Jersey	—	2.4	5.6	3.9
	2.5	10.0	20.5	19.1
North Central				
Illinais	—	1.7	7.9	6.1
Ohio	1.0	3.6	5.8	5.1
Michigan	1.2	4.2	4.2	4.6
Indiana	—	0.7	2.5	2.4
Missauri	—	0.2	2.7	2.1
Wiscansin	3.5	6.0	6.1	2.1
Minnesata	1.7	2.1	1.0	1.8
Other	1.0	0.1	4.6	3.8
	8.4	18.6	34.8	28.0
South				
Texas	—	3.3	2.7	5.2
Flarida	6.8	4.2	2.2	3.7
Virginia	4.2	3.9	0.9	2.3
Georgia	11.0	7.2	3.2	2.0
Lauisiana	7.8	6.2	1.5	1.4
Alabama	8.5	6.3	1.8	1.2
South Caralina	4.8	3.7	0.9	1.0
Arkansas	3.6	2.6	1.9	0.7
Mississippi	4.8	—	0.3	0.8
Other	13.6	11.7	10.1	9.7
	65.1	49.1	25.5	28.0
West				
Califarnia	—	3.2	8.1	11.2
Washingtan	7.7	4.4	1.0	1.8
Oregan	6.0	5.2	*	1.0
Other	4.6	1.5	2.4	4.9
	18.3	14.3	11.5	18.9
TOTAL	100.0%	100.0%	100.0%	100.0%

[1]Source: The Kline Guide to the Paper and Pulp Industry, 1976, page 28

Exhibit XII-3

GEOGRAPHIC DISTRIBUTION OF THE U.S. PAPER INDUSTRY[1]



[1]Source: The Kline Guide to the Paper and Pulp Industry, 1976, page 28.

Waterborne movements of logs only occur when convenient access exists to the forest area and the sawmills that ultimately cut the logs into lumber.

HANDLING OF LOGS, PULPWOOD LOG AND PULP

Pulp is handled in a bulk form. Normally it is loaded into barges by a conveyor belt system and discharged by a grab. Open or closed hopper barges may be utilized for the carriage of bulk pulp.

Logs and pulpwood logs are handled with specialized equipment and discharged in the same manner. Pulpwood logs may be bound together with straps or chains, whereas logs normally are loaded individually and secured in place. Logs and pulpwood logs may be carried either in a hopper type barge or on a deck barge.

LUMBER AND WOOD PRODUCTS GROUP

Exhibit XII-4 shows movements of lumber and wood products by state. Exhibit XII-5 shows aggregate movements of the group for the years 1969-1976. The group has experienced little growth during this period and represents only about 0.2 percent of the entire tonnage moved in the study region in 1976.

Exhibit XII-4

LUMBER AND WOOD PRODUCTS GROUP MOVEMENTS
1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	9,214	399,646	309,694
Arkasnas	179	71,807	12,987
Illinois	123,157	20,730	2,141
Indiana	330	2,011	0
Iowa	941	2,447	0
Kansas	0	0	0
Kentucky	0	23,127	0
Louisiana	171,243	124,279	174,625
Minnesota	0	0	0
Mississippi	263,940	79,286	278,895
Missouri	42,878	26,733	5,847
Nebraska	0	0	0
Ohio	0	22,992	0
Oklahoma	1,036	0	0
Pennsylvania	2,596	0	0
Tennessee	214,756	84,161	93,111
West Virginia	0	0	0
Wisconsin	0	3,377	0
Total	830,270	860,596	864,313

Source: Temple, Barker & Sloane, Inc.

Exhibit XII-5

LUMBER AND WOOD PRODUCTS GROUP SHIPMENTS
1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	591,004	578,702	1,188,695	2,358,401
1970	568,819	577,014	1,426,396	2,572,229
1971	604,841	697,441	1,392,929	2,695,211
1972	884,265	913,362	1,153,925	2,951,552
1973	764,435	751,496	1,089,769	2,605,694
1974	998,470	910,660	987,127	2,896,257
1975	851,446	926,672	856,021	2,634,139
1976	830,270	860,596	864,313	2,555,179

Source: Temple, Barker & Sloane, Inc.

XIII. SUGAR AND MOLASSES GROUP

This group includes only two U.S. Army Corps commodity classifications:

2061 Sugar
2062 Molasses

These commodities were grouped because of their relationship to the sweetener industry. Molasses is actually a by-product of sugar production; however, it is included as its production varies directly with that of sugar although demand may not.

These two products have also been separated from other agricultural commodities because of their special handling characteristics.

Exhibit XIII-1 shows the tonnage of each commodity moved in 1976 and its percentage of the group total.

SUGAR AND MOLASSES PRODUCTION

Sugar is produced from two basic raw materials, sugarbeets and sugarcane. Sugarbeets are grown in 17 states with the states of California, Idaho, Washington, Minnesota, Colorado, Michigan, Montana, and North Dakota representing over 72 percent of the total production. These states with the exception of Minnesota are all outside the Mid-America Region.

Exhibit XIII-1

BREAKDOWN OF SUGAR
MOLASSES GROUP BY COMMODITY

Commodity	Short Tons*	Percent*
Sugar	509,861	41.1
Molasses	730,677	58.9
Total	1,240,539	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

Sugarcane is raised in the states of Florida, Hawaii, Louisiana and Texas. Exhibit XIII-2 shows the production of sugarcane for each state in 1975. By contrast, the sugarcane industry is much more concentrated in the United States than is the sugarbeet industry. The four sugarcane states produce 28.5 million tons of sugarcane, whereas the 17 sugarbeet states raised 29.3 million tons in 1975[1].

Sugarcane and sugarbeets, once harvested, are processed or refined into raw sugar and molasses. This raw sugar is then further refined into the white and brown sugar that is normally consumed or used in food processing. The secondary refining also produces molasses as a by-product which is used for human consumption directly or in food processing and cattle feed.

In 1975 the United States met 62 percent of its demand for sugar through domestic production. The balance was imported from territories or foreign countries.

Exhibit XIII-3 shows both beet and cane sugar refinery locations in the United States. It is apparent from the exhibit that the sugarbeet refining capacity has little impact on the Mid-America Region. It is the imports of raw sugar and molasses that give rise to the greatest volume of inland waterway movements of this group.

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[1] Agricultural Statistics, 1976, U.S. Department of Agriculture, page 74.

Exhibit XIII-2

UNITED STATES SUGARCANE PRODUCTION, 1975*

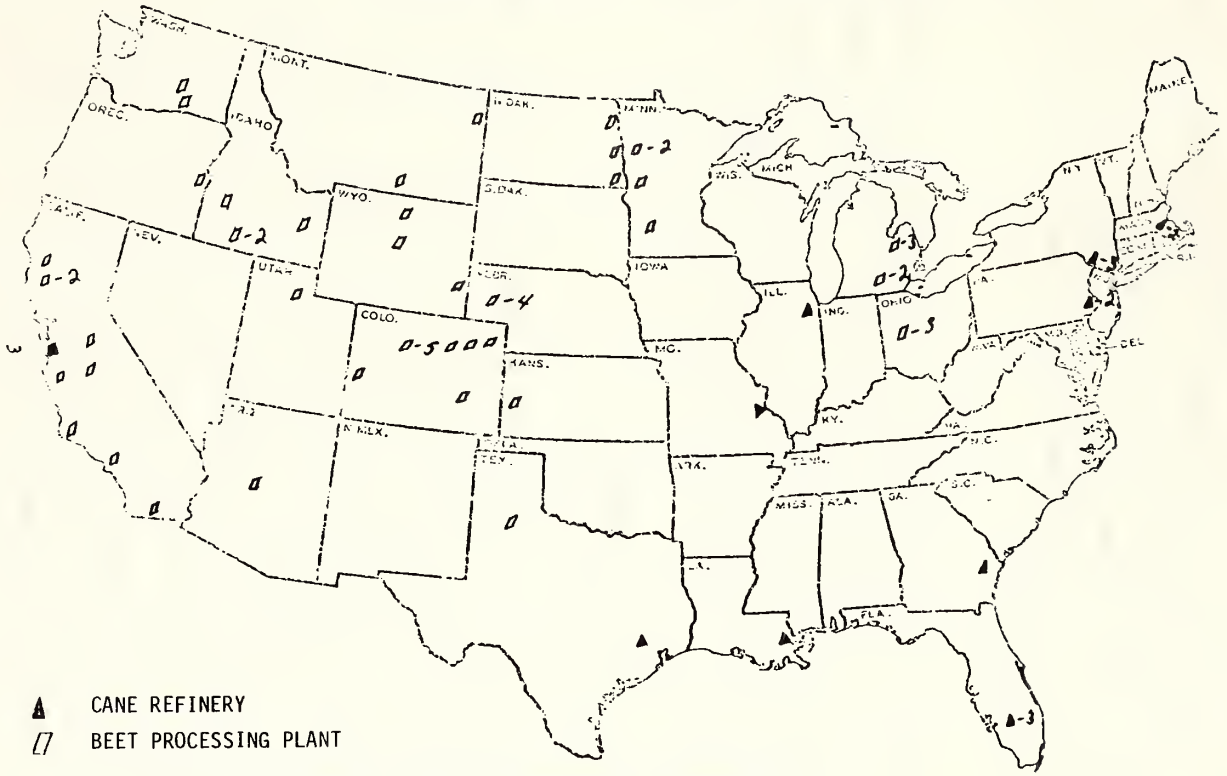
State	Thousands of Short Tons	Percent
Florida	9,860	34.6
Hawaii	10,403	36.5
Louisiana	7,074	24.8
Texas	1,162	4.1
Total	28,499	100.0

*Source: Agricultural Statistics, 1976, U.S. Department of Agriculture, page 78.

Exhibit XIII-3

GEOGRAPHIC LOCATIONS OF
CANESUGAR AND BEET SUGAR PROCESSING PLANTS[1]

Location of Cane Sugar Refineries and Beet Sugar Processing Plants



Source: Federal Trade Commission, Bureau of Economics (see Appendix C).

[1]Source: Staff Economic Report-The U.S. Sugar Industry, July 1975, page 3.

SUGAR AND MOLASSES HANDLING

Refined sugar is not transported in barges except in a packaged state as it is destined for ultimate human consumption. Raw sugar is transported in covered hopper barges in bulk form as it will be further refined before consumption. Raw sugar may be loaded via conveyor belts or by buckets. It is normally discharged from barges at refineries by buckets.

Molasses is transported in compartmented barges designed for the carriage of liquids. Molasses may require heating before pumping in cooler climates. The discharge of molasses from barges is handled at liquid bulk facilities from which it can be transferred to tank trucks.

SUGAR AND MOLASSES MOVEMENTS

Exhibit XIII-4 shows the movements of the sugar and molasses group for the year 1976 by state. The only major net shipper of sugar and molasses is the state of Louisiana. This situation is a result of the foreign imports which are transferred to barges from oceangoing vessels in the lower Mississippi. The largest receivers of the group are Illinois, Iowa, Missouri and Nebraska, all of which are among the top nine largest cattle raising states in the United States. Some raw sugar moves to Illinois and Missouri refineries; however, the balance of the movements are comprised of molasses shipments destined to cattle raising areas.

Exhibit XIII-5 shows the aggregate shipments and receipts of the sugar and molasses group for the years 1969-

1976. During this period there has been little change in the volume of movements. The group represents only 0.2 percent of the total tonnage moved in the study area in 1976.

Exhibit XIII-4

SUGAR AND MOLASSES GROUP MOVEMENTS

1976

(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	1,292	16,934	4,498
Arkansas	3,636	0	0
Illinois	371,728	4,373	5,425
Indiana	3,986	0	0
Iowa	130,481	0	0
Kansas	6,323	0	0
Kentucky	20,571	0	0
Louisiana	59,396	1,027,474	109,549
Minnesota	74,697	31,684	0
Mississippi	0	1,320	0
Missouri	125,624	907	0
Nebraska	125,442	0	0
Ohio	56,168	0	0
Oklahoma	29,913	0	0
Pennsylvania	7,652	0	0
Tennessee	42,336	4,218	0
West Virginia	1,264	0	0
Wisconsin	7,403	0	0
Total	1,067,912	1,086,910	119,472

Source: Temple, Barker & Sloane, Inc.

Exhibit XIII-5

SUGAR AND MOLASSES GROUP SHIPMENTS

1969-1976

(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	1,187,161	1,050,440	67,700	2,305,301
1970	1,193,974	1,115,165	107,410	2,416,549
1971	1,288,996	1,207,698	91,263	2,587,957
1972	1,267,368	1,256,947	118,462	2,642,777
1973	1,125,630	1,061,573	115,498	2,302,701
1974	1,218,768	1,080,610	124,154	2,423,532
1975	1,040,861	919,503	194,182	2,154,546
1976	1,066,620	1,086,910	119,472	2,273,002

Source: Temple, Barker & Sloane, Inc.

XIV. PRIMARY FERROUS AND NONFERROUS METALS PRODUCTS GROUP

The Primary Ferrous and Nonferrous Metals Group includes the following U.S. Army Corps of Engineers classifications:

3311	Pig Iron
3314	Iron and Steel Ingots and Other Primary Forms
3315	Iron and Steel Bars, Rods, Shapes, Sections, including Sheet Piling
3316	Iron and Steel Plates and Sheets
3317	Iron and Steel Pipe and Tube
3318	Ferroalloys
3319	Primary Iron and Steel Products, NEC
3321	Primary Nonferrous Products, except Copper, Lead, Zinc, andAluminum
3322	Copper
3323	Lead and Zinc
3324	Aluminum

These commodities were grouped due to their direct relationship to the primary metals industry and because of their similar handling and transportation requirements. These commodities are all matched with MarAd's terminal classification for the handling of primary metal forms.

Exhibit XIV-1 shows the tonnage of each commodity that moved on the inland waterways of the Mid-America Region in

Exhibit XIV-1

BREAKDOWN OF THE PRIMARY FERROUS AND
NONFERROUS METAL PRODUCTS GROUP BY COMMODITY

Commodity	Short Tons*	Percent*
Pig Iron	76,068	1.2
Iron and Steel Ingots	659,262	10.4
Iron and Steel Bars, Rods, Shapes, Sections	1,052,283	16.6
Iron and Steel Plates and Sheet	2,554,640	40.3
Iron and Steel Pipe and Tube	748,008	11.8
Ferro-alloys	735,330	11.6
Primary Iron and Steel Products, NEC (except copper, lead, zinc, aluminum)	3,389	--
Copper	88,746	1.4
Lead and Zinc	171,154	2.7
Aluminum	95,085	1.5
Total	6,339,057	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

1976, and the percentage that the tonnages represent of the entire group. It should be noted that the primary forms of iron and steel represent in excess of 94 percent of the total group. The nonferrous metals will not be discussed further as they represent such a very small portion of the total movement.

IRON AND STEEL PRODUCTION AND MARKETS

The U.S. production of iron and steel is concentrated in the Ohio River Valley area and along the southern shores of the Great Lakes. Other areas produce steel, but the regions cited account for 78 percent of the total U.S. production of raw steel. Exhibit XIV-2 shows production of raw steel by state.

The United States imports substantial volumes of steel mill products each year. These imports give rise to much of the inland waterway traffic of ferrous metal products. Likewise, the U.S. exports primary forms of steel but in much smaller volume. In 1976 the U.S. imported 17.3 million tons of steel mill products while exporting only 2.7 million tons[1].

HANDLING OF FERROUS AND NONFERROUS METAL PRODUCTS

As indicated by the commodity titles included in this group, these products are handled in several different shapes

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[1]Source: Annual Statistic Report, American Iron and Steel Institute, 1976, pages 38, 42.

Exhibit XIV-2

RAW STEEL PRODUCTION BY STATE

1976*

(thousands of short tons)

State	Tons	Percent of Total
New York	4,799	3.7
Pennsylvania	26,696	20.9
Rhode Island, Connecticut, New Jersey, Delaware, & Maryland	5,870	4.6
West Virginia, Virginia, Georgia, Florida, North Carolina, South Carolina, & Louisiana	5,403	4.2
Kentucky	2,206	1.7
Alabama, Tennessee, Mississippi, and Arkansas	4,109	3.2
Ohio	22,419	17.5
Indiana	22,178	17.3
Illinois	11,030	8.6
Michigan	10,382	8.1
Minnesota, Missouri, Oklahoma, Texas, Nebraska & Iowa	5,079	4.0
Arizona, Colorado, Utah, Washington, Oregon & Hawaii	4,431	3.5
California	3,398	2.7
Total	128,000	100.0%

*Source: Annual Statistic Report, American Iron and Steel Institute, 1976, page 55.

and sizes. The loading and discharging of barges therefore require different types of cargo handling apparatii for the different commodities. Most transfers are made with cranes or booms with specialized slings attached depending on the size and shape of the commodity being handled. Pipes, tubes, bars, angles, shapes and rods are often strapped together in bundles thereby handling several for each cycle of the crane. Likewise, ingots may also be strapped, however, the gear used will normally vary substantially from that used for the other shapes.

Closed hopper barges are used to transport these commodities. No special care is required other than maintaining the products in a dry condition as the iron and steel oxidizes with prolonged contact with moisture.

MOVEMENTS OF THE FERROUS AND NONFERROUS METAL PRODUCTS GROUP

Exhibit XIV-3 shows the shipments and receipts of the ferrous and nonferrous metals group by state for 1976. The largest volume of shipments originates in Louisiana. These shipments are almost exclusively imports of steel products which are transferred to barges for transshipment to other areas within the region. The steel producing areas of Pennsylvania, Ohio, West Virginia, Missouri, Kentucky, and Alabama also shipped in excess of 100,000 tons of steel via the waterways. Over 500,000 tons of steel were also shipped from Illinois, however, much of this was transshipments of foreign imports to barges for inland transit.

Exhibit XIV-4 shows the aggregate tons of ferrous and nonferrous metal products shipped for the years 1969-1976.

There has been virtually no growth in the total amount of shipments and receipts, however, this is partially due to the sharp decline in intrastate movements as the interstate movements have increased slightly over the period.

Exhibit XIV-3

PRIMARY FERROUS AND NONFERROUS
METAL PRODUCTS GROUP MOVEMENTS

1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	194,726	133,765	47,161
Arkansas	127,261	4,673	0
Illinois	904,890	565,480	54,613
Indiana	134,702	14,550	2,247
Iowa	21,697	5,367	0
Kansas	0	0	0
Kentucky	333,973	184,758	0
Louisiana	589,755	2,067,527	442,569
Minnesota	139,245	1,800	0
Mississippi	106,711	14,720	824
Missouri	404,627	210,731	4,398
Nebraska	25,732	0	0
Ohio	400,700	291,828	12,022
Oklahoma	118,834	1,265	564
Pennsylvania	274,528	1,132,290	50,746
Tennessee	735,973	26,961	2,354
West Virginia	332,592	301,153	9,919
Wisconsin	2,245	0	0
Total	4,848,191	4,956,868	627,417

Source: Temple, Barker & Sloane, Inc.

Exhibit XIV-4

PRIMARY FERROUS AND NONFERROUS
METAL PRODUCTS GROUP SHIPMENTS

1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	4,092,639	4,320,501	1,692,401	10,105,541
1970	5,227,080	5,205,035	1,569,233	12,001,348
1971	4,733,322	4,933,736	1,415,768	11,082,826
1972	4,879,229	5,202,052	1,661,995	11,743,276
1973	5,179,696	5,207,274	1,517,699	11,904,669
1974	5,789,956	5,990,699	977,549	12,758,204
1975	4,635,443	5,047,827	831,009	10,514,279
1976	4,848,191	4,956,868	627,417	10,432,476

Source: Temple, Barker & Sloane, Inc.

XV. COMMODITY GROUP 13
FABRICATED METAL PRODUCTS GROUP

The Fabricated Metal Products Group includes the following U.S. Army Corps of Engineers commodity classifications:

3411 Fabricated Metal Products, except Ordnance, Machinery, and Transportation Equipment

3511 Machinery, except Electrical

Exhibit XV-1 shows the tons of each commodity moved on the inland waterways of the Mid-America report in 1976 and the percent these tons represent of the total group tonnage.

These commodities were grouped due to their common relationship to the manufacturing section of the economy. These commodities are industrial in nature and the total movements can be expected to vary with business investment.

Fabricated Metal Products Handling

Fabricated metal products and machinery normally require specialized cargo handling equipment. Much care has to be given to their loading and discharging operations due to the value of the commodities.

It is mandatory that these items be kept dry during shipping, as parts of the machinery are subject to rust and corrosion. This equipment is therefore transported in closed hopper type barges when possible. Occasionally, equipment is moved on deck barges due to its size and bulk which render it impossible to be stowed within a barge.

Exhibit XV-1

BREAKDOWN OF THE FABRICATED
METAL PRODUCTS GROUP BY COMMODITY

Commodity	Short Tons*	Percent*
Fabricated Metal Products	213,263	39.8
Machinery, except Electrical	322,575	60.2
Misc. Fabricated Metal Products	0	0
Total	535,839	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

These commodities are normally loaded and discharged at general cargo type facilities. Occasionally direct ship-to-barge and barge-to-ship transfers, particularly for exports or imports, are made without landing the equipment at port of transshipment. Movements of these products also occur from manufacturing point to final site location where the product is to be used. These movements may occur due to the size and shape of the equipment which would render it difficult or impossible to be moved overland. Obviously, such specialized movements can only occur where the point of manufacturing and final site are located on the waterways.

Fabricated Metal Products Movements

Exhibit XV-2 shows the movements of the group by state for the year 1976. The state of Louisiana is the largest shipper of the group due to the products being imported and transferred from ocean going vessels to barges for inland transportation. Other than the movements of imports out of Louisiana and the movement of exports to Louisiana, few generalizations about the flows of these products can be made.

Exhibit XV-3 shows the aggregate shipments and receipts of the Fabricated Metal Products Group for the years 1969-1976. It is apparent from this exhibit that these shipments are very cyclical. The recession years 1974-1975 are also the lowest volume years which suggests that the group is very sensitive to capital spending.

The Fabricated Metals Product Group represents only 0.1 percent of the total tonnage moved on the inland waterways in the Mid-America Region in 1976. However, this group

represents cargo that has specialized handling characteristics and requirements, and as such the revenues earned by the barge lines on these commodities per ton are much larger than the lower value bulk commodities.

Exhibit XV-2

FABRICATED METAL PRODUCTS GROUP MOVEMENTS

1976

(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	31,741	15,280	6,969
Arkansas	2,047	0	400
Illinois	36,428	25,576	8,610
Indiana	5,403	2,889	0
Iowa	260	119	0
Kansas	525	0	0
Kentucky	14,921	9,451	1,258
Louisiana	41,492	126,762	148,510
Minnesota	0	129	0
Mississippi	6,708	7,858	1,400
Missouri	23,992	15,419	1,250
Nebraska	1,365	0	0
Ohio	34,130	5,423	303
Oklahoma	745	1,433	0
Pennsylvania	5,453	85,196	23,357
Tennessee	11,440	12,053	5,831
West Virginia	71,396	2,477	2,241
Wisconsin	0	0	0
Total	288,048	310,065	200,129

Source: Temple, Barker & Sloane, Inc.

Exhibit XV-3

FABRICATED METAL PRODUCTS GROUP SHIPMENTS
1969-1976

	Inbound	Outbound	Intrastate	Total
1969	569,147	593,337	132,942	1,295,426
1970	324,153	360,323	115,447	799,923
1971	768,372	804,336	92,987	1,665,695
1972	347,110	401,859	91,566	840,535
1973	276,260	329,355	111,543	717,158
1974	215,868	259,339	104,716	579,923
1975	208,202	244,567	140,854	593,623
1976	288,048	310,065	200,129	798,242

Source: Temple, Barker & Sloane, Inc.

XVI. COMMODITY GROUP 14
SCRAP METALS GROUP

The Scrap Metals Group includes the following two U.S. Army Corps of Engineers commodity classifications.

4011 Iron and Steel Scrap
4012 Nonferrous Metal Scrap

These commodities were grouped due to their common relationship to the primary metals industry. Both of these commodities are used as a raw material input to the steel and the nonferrous metals industries. In addition to their demand characteristics, the commodities have similar handling characteristics and are handled at terminals classified by MarAd as type V terminals which are designated as handling scrap metals.

Exhibit XVI-1 shows the tons of each commodity moved on the inland waterways in the Mid-America Region in 1976 and the percent of the total group that these tons represent. As can be seen, scrap iron and steel represent over 91 percent of the total tonnage moved.

Scrap Metals Handling

Scrap metals do not require any special handling and normally older barges are used to carry these commodities. In the case of scrap steel, much of it consists of junked automobiles which have been crushed into a compact cube. Normally the engine blocks and transmissions

Exhibit XVI-1

BREAKDOWN OF SCRAP METALS
GROUP BY COMMODITY TONS AND PERCENT

Commodity	Short Tons*	Percent*
Iron and Steel Scrap	1,425,930	91.5
Nonferrous Metal Scrap	132,463	8.5
Total	1,558,394	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

have been removed from the autos before crushing. Scrapped automobiles tend to be dirty in the sense that they are often covered with oil and grease, which often precludes the barges employed in scrap operations from being utilized for cleaner trades. Normally open hopper barges are utilized for the carriage of scrap metals.

Iron and steel scrap is loaded and discharged with cranes which utilize electric magnets for picking up the cargo. The nonferrous metals by contrast are normally handled by a grab as they are not attracted by magnets.

Scrap Metals Group Movements

Exhibit XVI-2 shows the movements of scrap metals in 1976 by state. It is apparent from this exhibit that much of the scrap metals are being shipped out of the Mid-America region as evidenced by the imbalance between total inbound and total outbound tonnages. These out of Mid-America region shipments are the result of large shipments of iron and steel scrap from Alabama and the Mississippi River to Texas via the Gulf Intracoastal waterway.

Other large volume movements of scrap metals occur in the states of Pennsylvania and Illinois (East St. Louis). These movements result as a direct demand of the steel industry for scrap and as a result of export demand. The Ports of New Orleans and Mobile together export about 200,000 tons of scrap steel per year.

The major movements of the nonferrous metal scrap occur on the Ohio, Allegheny and Monongahela Rivers.

Exhibit XVI-3 shows the aggregate movements of scrap metals for the years 1969-1976. Although the movements increased in volume by 75 percent over the seven year period, it cannot be said that the growth was steady. The volume of movements has been highly variable over this period and one of the lowest volume years was 1975, an economic recession year.

The scrap metals group accounts for about 0.4 percent of the total tonnage moved on the inland waterways in the year 1976.

Exhibit XVI-2

SCRAP METALS GROUP MOVEMENTS

1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	13,167	412,155	24,024
Arkansas	0	23,563	0
Illinois	223,576	114,543	96,425
Indiana	0	47,051	0
Iowa	3,006	25,554	0
Kansas	0	0	0
Kentucky	31,051	110,825	0
Louisiana	87,158	68,092	38,684
Minnesota	7,323	17,127	1,290
Mississippi	2,660	92,416	0
Missouri	7,764	111,717	0
Nebraska	0	1,657	0
Ohio	19,396	101,461	2,608
Oklahoma	0	0	0
Pennsylvania	256,208	31,426	1,944
Tennessee	29,080	155,052	0
West Virginia	53,009	38,095	2,580
Wisconsin	0	4,582	0
Total	733,398	1,355,316	167,555

Source: Temple, Barker & Sloane, Inc.

Exhibit XVI-3

SCRAP METALS GROUP SHIPMENTS
1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	565,368	603,002	122,365	1,290,735
1970	658,221	653,612	123,788	1,435,621
1971	583,253	530,143	80,837	1,194,233
1972	627,348	568,201	115,268	1,310,817
1973	727,359	733,730	98,445	1,559,534
1974	788,463	972,154	200,252	1,960,869
1975	415,283	627,898	162,499	1,205,680
1976	733,398	1,355,316	167,555	2,256,269

Source: Temple, Barker & Sloane, Inc.

XVII. COMMODITY GROUP 15
CONSTRUCTION MATERIALS GROUP

The Construction Materials Group includes the following U.S. Army Corps of Engineers commodity classifications:

1411 Limestone Flux and Calcareous Stone
1412 Building Stone, Unworked
1442 Sand, Gravel, Crushed Stone
2951 Asphalt Building Materials
3241 Cement
3271 Lime
3281 Cut Stone and Stone Products

These commodities were grouped due to their common relationship to the construction industry and the demand for construction materials. Construction as used here is to be construed as including highway projects and other public works as well as the housing industry. The commodities also have similar handling characteristics inasmuch as they are all moved in a dry bulk form.

Exhibit XVII-1 shows the tons of each commodity moved on the inland waterways in the Mid-America region in 1976 and the percent of the total group these tons represent. Two commodities, sand and gravel and cement, account for almost 95 percent of the total construction materials group moved in 1976.

Exhibit XVII-1

BREAKDOWN OF CONSTRUCTION MATERIALS
GROUP BY COMMODITY TONS AND PERCENT

Commodity	Short Tons*	Percent*
Limestone	1,538,666	3.6
Building Stone	0	0.0
Sand, Gravel, Crushed Rock	36,799,769	86.1
Asphalt Building Materials	0	0.0
Cement	3,347,480	8.3
Lime	854,815	2.0
Cut Stone	0	0.0
Total	42,740,731	100.0%

*Numbers not may total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

The Sand and Gravel Industry

The primary consumer of sand and gravel is the construction industry. In 1974 the construction industry consumed 97 percent of the total tonnage of sand and gravel produced in the United States.[1]

Production of sand and gravel is a direct function of demand for the product and can vary drastically from year to year. A case in point is the construction of the Trans-Alaska Pipeline which created a tremendous demand for sand and gravel. Production in Alaska skyrocketed from 15 million tons in 1973 to 118 million tons in 1974 and can be expected to drop back close to its 1973 level upon completion of the project.[2]

Given the demand chasing characteristic of production, it is difficult to project future production volumes without a thorough knowledge of construction projects planned in the future.

Reserves of sand and gravel would seem to be virtually unlimited given the vast acreage of the United States. However, reserves in some local areas are already becoming constrained due to suburban sprawl, rising land costs, and resistance from environmentalists. The constrained reserves situation can be expected to worsen in the future.

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[1] Minerals Yearbook, 1974, U.S. Department of the Interior, p. 1147.

[2] Ibid.

The result of the limited reserves in certain geographic areas will be to increase the distances that sand and gravel will be transported in the future. Vast reserves of sand and gravel exist, but can be located in areas where the transportation from production site to construction site would be uneconomical as compared to local reserves which demand a higher price. This trend is demonstrated by the 7 perecent increase in value of production between 1973 and 1974 despite a one percent decline in demand.[3]

Every state in the U.S. produced sand and gravel in 1974, however, the eight states of Alaska, California, Michigan, Illinois, Texas, Ohio, Minnesota and New York accounted for 477 million tons representing 49 percent of the total U.S. production. See Exhibit XVII-2 for production by state.

U.S. production of sand and gravel totaled 979 million tons in 1974. This figure was down slightly from 1973 production. Future production of sand and gravel is difficult to project but it is certain that the cost of sand and gravel will continue to climb due to the rising land costs, rising fuel and labor costs and the longer hauls involved.

The Cement Industry

The cement industry can be characterized as a homogenous, single product business. The industry is very regional in nature due to the relatively low value of the product. This

[3] Minerals Yearbook, 1974, U.S. Department of the Interior, p. 1153.

Table XVII-2

SAND AND GRAVEL PRODUCTION BY STATE

1974*

(thousands of short tons)

	Quantity	Percent
Alaska	117,752	12.0
California	105,191	10.7
Michigan	60,027	6.1
Illinois	42,705	4.4
Texas	42,466	4.4
Ohio	41,353	4.2
Minnesota	36,720	3.8
New York	30,614	3.1
Wisconsin	28,850	2.9
Indiana	26,077	2.7
Florida	24,372	2.5
Colorado	27,793	2.8
Arizona	23,417	2.4
Washington	22,842	2.3
Oregon	18,558	1.9
Others	330,017	33.8
Total	978,754	100.0%

*Minerals Yearbook 1974, U.S. Department of the Interior, p. 1153.

low value renders long distance shipments non-competitive unless there is a shortage of product in the destination region causing prices to rise.

The most commonly used cement is Portland cement, a hydrolic (water activated) variety. Portland cement is a nonmetallic mineral, composed primarily of limestone, clay or shale and gypsum.[4]

Cement production can be of the dry or wet process with the primary difference being that the wet process utilizes water to form a slurry of the raw materials for ease of handling within the plant. The trade-off in the wet process is the higher energy costs required in the kiln process.

The cement production process begins by crushing the raw materials rock. This crushed mixture is then either mixed with water to form a slurry (wet process) or handled in a dry powder state and is put into a large cylindrical, rotating kiln where it is heated to 1500 degrees centigrade to drive off the gases in the mixture. The cement clinkers that remain are small marble-sized pellets. These clinkers are then ground and mixed with gypsum to form fine powder substance, cement.[5]

Cement is a raw material input to the production of concrete. As such, cement by itself has no end use. The demand for cement varies directly with the demand for

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[4]Prices and Capacity Expansion in the Cement Industry, Staff Report, March 1977, p. 4.

[5]Ibid.

concrete, which in turn varies directly with construction spending.[6]

Exhibit XVII-3 shows the consumption of cement by construction sector for the years 1974 and 1975. The residential and commercial sectors were the largest users of cement, however, the projects using the most cement, i.e., dams, bridges, highways, etc., are found in the nonbuilding and transportation sectors. These sectors are characterized by a relatively small number of large projects whereas the residential and commercial sectors are characterized by a large number of relatively small projects.

Given the characteristics of demand for the major sectors it would be expected that the nonbuilding and transportation sectors would create the greatest fluctuations in demand as the cancellation of a few projects would reduce demand by a great amount. However, from Exhibit XVII-3, it is evident that this was not the case between 1974 and 1975 as the residential and commercial sectors' demand fell by 11.8 million tons whereas the nonbuilding and transportation sectors' demand actually rose 1.9 million tons while the total demand fell 12.1 million tons. This phenomenon was caused by the near collapse of the private sector real property industry in 1974-1975 and the fact that the large public works projects such as in the nonbuilding and transportation sectors, occur over a longer time horizon. Changes in the public sector construction spending, occur more gradually than in the private sector.

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[6]Ibid.

Exhibit XVII-3

CEMENT CONSUMPTION BY CONSTRUCTION SECTOR

1974 and 1975

Sector	1974		1975	
	Short Tons	% of Total	Short Tons	% of Total
Residential	18.5	23.4	14.9	22.2
Industrial/ Commercial	21.0	26.5	12.8	19.1
Nonbuilding	14.5	18.3	15.9	23.7
Transportation	12.5	15.8	13.0	19.4
Public Buildings	7.7	9.7	7.3	10.9
Miscellaneous	4.9	6.2	3.1	4.6
Domestic Shipments	73.4	92.8	63.9	95.4
Foreign Imports	5.7	7.2	3.1	4.6
Total Consumption	79.1	100.0	67.0	100.0

Source: Prices and Capacity Expansion in the Cement Industry, Staff Report March 1977, p. 8.

Cement plant capacity is located close to sources of limestone, the major raw material input on the basis of volume. If a plant's source of raw material is depleted and raw materials have to be shipped substantial distances, the transportation costs will render the plant uneconomical.

In the 1960's advances in technology and processes increased the economies of scale in production. This triggered a trend toward larger cement plants. Exhibit XVII-4 shows the trend toward larger plants for the period of 1948-1973.

Simultaneously with the plant size trend, a trend to bulk shipments was occurring. During the 1947-1973 period bulk shipments increased from less than 40 percent of total shipments to in excess of 90 percent.

These trends combined with new technologies in handling methods created opportunities for some companies to expand their markets by effectively locating new or expanding existing plants on the inland waterways system and constructing distribution facilities in market areas much further from their production facilities than was previously economically feasible. An example of this strategy is the Dundee Cement Co. which distributed cement from its Clarksville, Missouri plant (1.4 million tons annual capacity) in 1968 to points as distant as Minneapolis and Houston.[7] Higher raw material prices on the Gulf of Mexico coast added to the competitive advantage of this Missouri located plant.

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[7] Transportation of Mineral Commodities on the Inland Waterways of the South Central States, U.S. Department of the Interior, p. 24.

Exhibit XVII-4

DISTRIBUTION OF PORTLAND CEMENT PLANTS
BY ANNUAL CAPACITY FOR SELECTED YEARS

(percent)

	Annual Capacity (tons)					
	Less than 188,000	188,000-376,000	376,000-564,000	564,000-752,000	752,000-940,000	940,000 and Over
1948	8	56	17		19[a]	
1967	1	17	25	27	10	20
1971*	1	16	35	21	11	16
	Less than 183,000	183,000-350,750	350,750-518,500	518,000-701,500	701,500-854,000	854,000 and Over
1972*	1.9	15.9	31.5	21.6	8.8	20.3
1973*	1.3	13.3	26.2	25.4	6.5	27.3

*Data computed from daily clinker capacity.

[a]Applies to three size categories: 564,000 to 752,000 to 940,000, and 940,000 and 94,000 over.

Source: Prices and Capacity Expansion in the Cement Industry, Staff Report, March 1977, p. 28.

Limestone

As stated under the Cement Industry, limestone is the primary raw material utilized in the production of cement. Generally, cement plants are located near the source of limestone, therefore limestone is not normally transported in large volume for long distances.

An exception to this general rule is the flow of limestone from Albama to Louisiana cement plants. The Lone Star Cement Company hauls limestone from St. Stevens, Alabama to their New Orleans plant via the Tombigbee Waterway, Mississippi Sound and the Inner Harbor Navigation Canal in New Orleans. Other movements of limestone occur on the Mississippi River, however, not in the volume of the Lone Star Cement Company operation. On the Tennessee River and on the Monongahela River movements of limestone occur but the length of the hauls are much shorter than the Alabama to New Orleans movement.

Handling of Construction Materials

Sand and gravel require no special care in transit and is normally carried in open hopper barges. Sand and gravel is loaded by conveyor belts and clamshell grabs are usually used for discharging.

The handling and care requirements for limestone are basically the same as that for sand and gravel. Open hopper barges are utilized for the carriage of limestone.

Portland cement requires more care and more sophisticated handling equipment than do the other commodities in this group. Due to the hydraulic character of Portland

cement it is imperative that the product remain dry at all times. Barges utilized for the carriage of cement are usually compartmented and are fitted with a liner for moisture protection.[8]

Handling equipment for loading and discharging of cement is very specialized due to the powdery characteristics of cement. Although a gravity flow system may be utilized for loading of barges, normally pneumatic apparatus is used for discharging. Normally discharge points are distribution terminals equipped with rail and truck loading facilities and storage silos.

Movements of the Construction Materials Group

The most striking characteristic of the construction materials group movements is the fact that intrastate movements exceed the volume of interstate movements (see Exhibit XVII-5). This implies that the average length of haul for this group is much lower than the other groups. This is in fact the case for the dominant commodity, sand and gravel, which only had an average haul of 71.1 miles in 1975 internal traffic.[9] This fact is not surprising given the low value per ton of the commodities involved.

Given the short length of hauls involved in the construction materials group movements, it is difficult to make generalities about the flows. Any pattern of flows

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[8]Ibid, p. 25.

[9]Waterborne Commerce of the United States, Department of the Army Corps of Engineers, Part 5, p. 92.

Exhibit XVII-5

CONSTRUCTION MATERIALS GROUP MOVEMENTS
1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	324,670	1,478,664	2,129,821
Arkansas	112,219	221,881	2,418,661
Illinois	2,819,638	903,571	4,858,642
Indiana	90,475	3,975,144	600,398
Iowa	235,605	88,761	182,300
Kansas	0	0	0
Kentucky	2,494,043	3,396,869	2,253,335
Louisiana	1,574,828	23,949	249,331
Minnesota	162,479	0	1,576,871
Mississippi	1,049,101	119,747	119,997
Missouri	158,703	2,516,952	3,523,813
Nebraska	164,601	0	0
Ohio	1,406,219	3,067,279	152,667
Oklahoma	0	97,500	129,700
Pennsylvania	2,154,690	111,614	1,482,303
Tennessee	2,587,789	121,795	1,851,891
West Virginia	3,537,928	1,113,109	1,991,378
Wisconsin	88,166	0	0
Total	18,961,154	17,236,835	23,521,109

Source: Temple, Barker & Sloane, Inc.

that exist in one year could change drastically the next due to the variability in demand. One movement that is expected to continue is the flow of sand and gravel and limestone into the New Orleans area as these products do not exist in economically recoverable quantities in this area.

Table XVII-6 shows the aggregate movements of the group from 1969 to 1976. The group has experienced no growth over this period. In 1976 the construction materials group represented 9.6 percent of the total tons moved on the inland waterways of the study area.

Exhibit XVII-6

CONSTRUCTION MATERIALS GROUP SHIPMENTS

1969-' 76
(Shor' Tons)

	Inbound	Outbound	Intrastate	Total
1969	17,995,072	14,846,863	27,233,949	60,075,884
1970	18,047,039	15,509,343	26,625,743	60,182,125
1971	20,113,507	17,862,191	28,183,500	66,159,198
1972	20,395,662	18,163,762	25,917,631	64,477,055
1973	18,947,977	16,559,247	28,319,232	63,826,456
1974	20,711,604	18,171,094	26,364,495	65,247,193
1975	17,916,267	16,178,639	24,035,782	58,130,688
1976	18,961,154	17,236,835	23,521,109	59,719,098

Source: Temple, Barker & Sloane, Inc.

XVIII. COMMODITY GROUP 16 - MINING PRODUCTS GROUP NEC

The Mining Products, NEC group includes the following U.S. Army Corps of Engineers commodity classifications:

0931 Marine Shells, Unmanufactured
1451 Clay, Ceramic, and Refractory Materials
1491 Salt
1492 Sulfur, Dry
1494 Gypsum, Crude Plaster
1499 Nonmetallic Minerals, except Fuels, NEC

These commodities were grouped primarily due to their relationship to the mining sector and because of their similar handling characteristics. This group has been matched with the MarAd terminal classification G which is designated as terminals designed for the handling of non-specialized bulk commodities.

Exhibit XVIII-1 shows the tons of each commodity moved on the inland waterways of the Mid-America Region in 1976 and the percent of the total group that those tons represented. It is apparent from this exhibit that two commodity classifications account for almost 95 percent of the entire group. Salt tonnage is included under the Nonmetallic Minerals, NEC commodity classification to avoid disclosing the exact tonnage moved. Although the exact tonnage of salt moved is not known, it is estimated that as much as 90-95 percent of the Nonmetallic Minerals, NEC group is comprised of salt. This would mean that the estimated tonnage of salt moved in 1976 ranged between 5.3 and 5.6 million tons.

Exhibit XVIII-1

BREAKDOWN OF THE MINING PRODUCTS, NEC
GROUP BY COMMODITY TONS AND PERCENT

Commodity	Short Tons*	Percent*
Marine Shells	8,923,948	56.8
Clay, Ceramic, Refractory Materials	832,692	5.3
Salt	**	**
Sulphur	3,333	--
Gypsum and Crude Plaster	0	0.0
Non-metallic Minerals, NEC	5,923,948	37.9
Total	15,711,176	100.0%

*Figures may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2 pages 32 and 33. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

**Actual salt tonnages are withheld by the U.S. Army Corps of Engineers to avoid disclosure of individual company operations. The tonnage for salt is included in the Non-metallic Minerals, NEC classification. Although it is impossible to determine the exact percent of the Non-metallic Minerals, NEC group that represents salt, it is estimated that approximately 90 percent of that group is salt. This implies that 5.3 million tons of salt were moved on the inland waterways of the study area.

Marine Shells

Marine shells are mined primarily in the Gulf Coastal area by dredging. They are used as an aggregate for the construction industry and as a source of limestone for the cement industry. As an aggregate, one of the main uses is as road ballast or fill.

Marine shells are very low in value and consequently are not transported long distances. The greatest movements of marine shells occur in Louisiana for two reasons. One, shells are available in substantial quantities in the coastal area of Louisiana. Secondly, Louisiana does not have reserves of sand and gravel for use as a construction aggregate and the shells are a natural and economic substitute. As a result, large volumes of marine shells move in Louisiana intrastate traffic and some interstate movements also occur with Alabama and Texas. Exhibit XVIII-2 which shows the tonnages of Mining Products, NEC moving on the inland waterways, reflects the large volume of the marine shell business in Louisiana. Other sizable movements of marine shells occur in the coastal area of Alabama.

Salt

Salt is produced via a variety of production processes ranging from rock salt mining to methods of evaporating brine which is a salt solution. Reserves of salt in the United States and the world are virtually unlimited when the oceans are considered as a source. The major reserves of salt in the United States are the Gulf Coast Embankment located beneath the Gulf of Mexico and the states of Louisiana and Texas; the Salina Formation located around

Exhibit XVIII-2

MINING PRODUCTS, NEC GROUP MOVEMENTS
1976
(short tons)

	Inbound	Outbound	Intrastate
Alabama	555,050	286,675	1,175,838
Arkansas	5,474	2,855	0
Illinois	1,083,798	57,915	72,841
Indiana	125,223	0	0
Iowa	264,238	0	0
Kansas	0	0	0
Kentucky	548,288	43,147	1,500
Louisiana	131,305	6,306,392	7,211,140
Minnesota	334,668	0	0
Mississippi	231,641	0	0
Missouri	350,107	12,869	0
Nebraska	74,517	0	0
Ohio	518,797	2,833	9,773
Oklahoma	0	0	0
Pennsylvania	371,112	5,684	17,600
Tennessee	212,311	1,420	0
West Virginia	248,996	0	0
Wisconsin	111,239	0	0
Total	5,166,764	6,719,790	8,488,692

Source: Temple, Barker & Sloane, Inc.

Lake Erie; the Williston Basin located beneath the states of Montana, North Dakota and South Dakota; and the Permian Basin located beneath the states of New Mexico, Texas, Oklahoma, Kansas and Colorado.

Exhibit XVIII-3 shows the largest salt producing states and the percent of total U.S. production accounted for by these states. Total U.S. production in 1974 amounted to 46.423 million tons.

As stated in the foot note of Exhibit XVIII-1, tonnages of salt moving in domestic traffic of the United States are not released; however, the U.S. Army Corps of Engineers does release figures on ton-miles by commodity. In 1976 5.3 billion ton-miles of salt traffic occurred on the internal waterways. If an assumption is made that the average movement was 1,000 miles in length, then approximately 5.3 million tons of salt moved on the internal waterways. This figure is in agreement with the previous assumption that 90 percent of the Non-metallic Minerals, NEC (which included salt) commodity classification was composed of salt.

The chemical industry is by far the largest consumer of salt. Salt usage for highway deicing and by feed dealers are additional uses of the commodity. Exhibit XVIII-4 shows the distribution of salt sales by types of end-use for the year 1974.

Salt consumption by state and shipments by destination data is spotty due to the extent of withheld information necessary to avoid the disclosure of proprietary information. However, the largest receiving states of evaporated and rock salt are shown in Exhibit XVIII-5.

Exhibit XVIII-3

LARGEST SALT PRODUCING STATES*
(thousands of short tons)

State	Tons	Percent of Total
Louisiana	13,463	29.0
Texas	11,142	24.0
New York	6,499	14.0
Ohio	5,107	11.0
Michigan	4,642	10.0
Other	5,570	12.0
Total	46,423	100.0

*Source: Minerals Yearbook, 1974, U.S. Department of the Interior, p. 1132.

Exhibit XVIII-4

SALT SALES BY TYPE OF USER[1]

1974

	Tons*	Percent of Total
Chlorine	23,080	49.4
Soda Ash	4,563	9.7
All Other Chemicals	1,734	3.7
Highway Use	7,757	16.6
Feed Dealers	1,512	3.2
Grocery Stores	1,252	2.7
Water Softener(s)	835	1.8
Other Food Processing	614	1.3
All Other Uses	5,344	11.4
Total	46,691	100.0

*Numbers may not total due to rounding.

[1]Source: Minerals Yearbook, 1974, U.S. Department of the Interior, p. 1134.

Exhibit XVIII-5

LARGEST RECEIVERS OF EVAPORATED AND ROCK SALT
1974
(thousands of short tons)

State	Tons
New York	2,166
Ohio	1,861
Pennsylvania	1,313
Illinois	1,445
New Jersey	900
Indiana	759
Washington	745

Source: Minerals Yearbook, 1974, U.S. Department of the Interior, p. 1132.

The general pattern of movements of salt is from the lower Mississippi (Louisiana) to upriver points in almost every state of the Mid-America region. Only Kansas and Oklahoma do not receive salt shipments due to in-state production or perhaps because of their proximity to the Texas production area. Not all of these receipts originate from the Louisiana area but the vast majority do. Only a limited volume of salt is shipped interstate via water transportation in the upper Mid-America region. These movement patterns are evident from Exhibit XVIII-2 which shows both inbound and outbound movements of the Mining Products, NEC group. Given that about 90 percent of the Non-metallic Minerals, NEC group is composed of salt and that virtually no marine shells are moved on the upper reaches of the Mississippi River System, then the movements into the upper Mississippi River system states are composed of salt from Louisiana.

Handling of the Mining Products, NEC Group

Marine shells and clay are both transported in open hopper type barges and do not require any special care in transit. Normally these commodities are discharged by clamshell type grabs. Loading of clay may take the form of a conveyor belt or other mechanical means. Marine shells are normally loaded directly from a dredging vessel into the barge that will transport the shells to their final destination or to a waterside stockpile close to the construction site where the shells will be utilized.

Salt is normally loaded with a conveyor system specialized for the loading of salt. Salt may be transported in either open or closed hopper barges and requires no special care in transit. Terminals receiving salt may have specialized discharging equipment if volumes are sufficiently large to warrant the investment, otherwise, general bulk material handling equipment such as cranes with clamshell grabs.

Mining Products, NEC Movements

The general pattern of movements for the two major commodities have already been discussed. The volume of movements of the Mining Products, NEC group are shown in Exhibit XVIII-6 for the years 1969-1976. The group has experienced a slight decline in volume over this period, however, the trend has been close to flat.

The group represents 3.5 percent of the total tonnage moved on the inland waterways of the Mid-America region in 1976.

Exhibit XVIII-6

MINING PRODUCTS NEC GROUP SHIPMENTS
1969-1976

	Inbound	Outbound	Intrastate	Total
1969	5,134,324	8,024,098	8,565,591	21,724,013
1970	5,478,624	7,752,936	9,177,024	22,408,584
1971	5,552,640	8,223,301	9,032,741	22,808,682
1972	5,573,354	6,969,634	9,679,534	22,222,522
1973	4,806,721	6,548,154	10,150,987	21,505,862
1974	5,467,320	6,396,135	11,230,532	23,093,987
1975	5,381,502	6,337,278	9,891,747	21,610,527
1976	5,166,764	6,719,790	8,488,692	20,375,246

Source: Temple, Barker & Sloane, Inc.

XIX. COMMODITY GROUP 17

NON-DURABLE MANUFACTURES, NEC INCLUDING PROCESSED FOODS

The Non-Durable Manufactures, NEC Group includes the following U.S. Army Corps of Engineers commodity classifications:

2011 Meat; Fresh, Chilled, Frozen

2012 Meat and Meat Products, Prepared or Preserved, including Canned Metal Products

2014 Tallow, Animal Fats and Oils

2015 Animal By-products, NEC

2021 Dairy Products, except Dried Milk and Cream

2022 Dried Milk and Cream

2031 Fish and Fish Products (including Shellfish), Prepared and Preserved

2034 Vegetables and Preparations, Preserved, Canned, and Otherwise

2039 Fruits and Fruit or Vegetable Juices, Canned

2081 Alcoholic Beverages

2091 Vegetable Oils, All Grades; Margarine and Shortening

2092 Animal Oils and Fats, NEC including Marine

2094 Groceries

2095 Ice

2099 Miscellaneous Food Products

2111 Tobacco Manufactures

2211 Basic Textile Products, except Textile Fibers

2212 Textile Fibers, NEC

2311 Apparel and Other Finished Textile Products, including Knits

2621 Newsprint (standard)

2631 Paper and Paperboard

2691 Pulp, Paper, and Paperboard Products, NEC

2711 Printed Matter

2831 Drugs

2841 Soap, Detergents, and Cleaning Preparations; Perfumes, Cosmetics and Other Toilet Preparations

3111 Leather and Leather Products

These commodities were grouped primarily because of their handling and care requirements. All products in this group have had value added due to processing and/or packaging which results in a relatively high per ton value. Only the vegetable and animal fats and oils are shipped in bulk (liquid). All other commodities are shipped in breakbulk form. Because of the breakbulk nature of the group, these commodities have been matched with the MarAd terminal classification for general cargos.

Exhibit XIX-1 shows the tonnage of each commodity within the group moved on the internal waterways in 1976 and the percentage of the total group represented by those tons.

Animal and Vegetable oils and fats including tallow account for 66 percent of the total tonnage moved within this group. Paper, paperboard, and products thereof account for another 31 percent of the group. All other commodities constitute only 3 percent (about 66,000 tons).

Exhibit XIX-1

BREAKDOWN OF THE NON-DURABLE MANUFACTURES, NEC
GROUP BY COMMODITY, TONS AND PERCENT

Commodity	Short Tons*	Percent*
Meat	0	0.0
Meat Products	8,856	0.4
Tallow, Animal Fats and Oils	201,489	9.1
Animal By-products, NEC	0	0.0
Dairy Products	0	0.0
Dried Milk and Cream	90	--
Fish and Fish Products	0	0.0
Shellfish Products	0	0.0
Canned Vegetables	149	--
Frozen Fruits	0	0.0
Canned Fruits	0	0.0
Fruit/Vegetable Juices, Canned	0	0.0
Alcoholic Beverages	11,070	0.5
Non-alcoholic Beverages	0	0.0
Vegetable Oils	1,169,084	52.8
Animal Oils and Fats	90,781	4.1
Roasted Coffee	0	0.0
Groceries	47	--
Ice	11,070	0.5
Misc. Food Products	11,070	0.5
Tobacco Manufactures	0	0.0
Basic Textile Products	19,927	0.9
Textile Fibers, NEC	0	0.0
Apparel & Other Finished Textile Prod.	0	0.0
Newsprint	6,642	0.3
Paper and Paperboard	628,825	28.4
Pulp, Paper, Paperboard Products, NEC	55,354	2.5
Printed Matter	0	0.0
Drugs	0	0.0
Soap, Detergents, & Cleaning Preparations	0	0.0
Leather & Leather Products	491	--
Total	2,214,175	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America Region.

Vegetable Oils and Animal Fats and Oils

The largest volume commodity in this group is vegetable oils which accounts for approximately 1.2 million tons. The major commodity within this commodity classification is soybean oil. Soybean oil is produced by crushing soybeans and separating the oil from the fiber of meal (soybean meal was discussed in Section XI - Grain Mill and Agricultural Products, NEC). Soybean oil is used primarily by the food processing sector.

The largest single commodity classification within this group is the Vegetable Oils. Exhibit XIX-2 shows the total U.S. production of vegetable oils. Soybean oil accounts for slightly over 80 percent of the total production. Exhibit XIX-3 shows U.S. exports of vegetable oils. Again, soybean oil accounts for almost 85 percent of the total exports. In terms of inland waterway movements of vegetable oils, soybean oil is unquestionably the largest volume commodity as the production areas are accessible to the inland waterways. This is not the case for linseed oil (produced from crushing flax seed) which is produced in the Northern Great Plains states and peanut oil which is produced primarily in the southeastern states of Georgia, North Carolina and Alabama.

Soybean oil movements occur as a result of demand created by exports and by the food processing sector. The movements between the food processors and the soybean crushing plants are accommodated by transportation modes other than water, by and large. The largest volume of movement are downbound flows from the states of Illinois,

Exhibit XIX-2

U.S. PRODUCTION OF VEGETABLE OILS*
1974

Commodity	Short Tons	Percent
Cottonseed Oil	673,500	14.8
Linseed Oil	123,500	2.7
Peanut Oil	94,183	2.1
Soybean Oil	3,672,500	80.4
Total	4,563,683	100.0%

*Source: Agricultural Statistics, 1976,
U.S. Department of Agriculture, pages 112-136.

Exhibit XIX-3

U.S. EXPORTS OF VEGETABLE OILS*

1974

Commodity	Short Tons	Percent
Cottonseed Oils	14,338	2.2
Linseed Oil	67,132	10.4
Peanut Oil	17,340	2.7
Soybean Oil	545,000	84.7
Total	643,810	100.0%

*Source: Agricultural Statistics, 1976
U.S. Department of Agriculture, pages 112-136.

Arkansas, Missouri, Mississippi, Iowa and Tennessee to Louisiana where the oil is transported in bulk to clean product carriers for ocean transportation. In 1976 575,000 tons of vegetable oil was exported from the Mississippi River.

The balance of movements in this commodity classification are accounted for by imports of vegetable oils, margarines and shortening. Approximately 450,000 tons were imported in 1976 with 165,000 tons being shipped to upriver destinations (primarily Illinois and Ohio).

Tallow and Animal fats and oils are byproducts of slaughter houses. These commodities are used in certain food and feed processing. The movements on the waterways, however, are a result of export demand for these products. The movements originate primarily from Chicago, the Minneapolis area, Iowa and Missouri. They terminate in the New Orleans area where they are loaded on oceangoing vessels for export.

Pulp and Paperboard

Production of paper and paperboard is increasingly becoming a Southeastern United States industry where abundant supplies of soft timber exist (see Exhibit XII-3, Geographic Distribution of Paper Industry"). As a result of the increased geographic concentration of paper production, the demand for paper transportation has increased, as the largest markets for paper and paper products are located in the Northeastern states and along the Ohio River Valley. Basically, local paper consumption is a function of population and manufacturing activity.

Waterborne transportation does not play a large role in the transportation of paper and paperboard as they lack the flexibility of delivering the products to the end users without incurring an intermodal transfer. In 1972 only 2.2 percent of the shipments from paperboard mills were via water transportation, and less than 1 percent of the paper mill shipments were by water.[1]

The waterways, however, have a competitive advantage for paper and paperboard exports. With the appearance of LASH barge-carrying ships, paper can be loaded at or near the paper mill into barges and does not require rehandling until the barge reaches the destination country. This eliminates at least one handling of the commodity which reduces the probability of damage.

The major shipping areas of paper and paperboard are the Arkansas, Tennessee, and Yazoo River. The predominant movements are downriver to the Lower Mississippi where the shipments are either exported or exit the Mississippi River system via the Gulf Intracoastal Waterway.

Handling of the Non-Durable Manufactures, NEC

The vegetable oils and animal fats and oils are transported in liquid bulk form. Clean barges must be utilized in the transportation of these commodities as their end use is for food or feed processing. Some of the commodities, such as tallow, may require heating in order to maintain the product in a pumpable state.

[1] 1972 Census of Transportation.

Paper and paperboard is normally transported in large rolls although paperboard can be shipped on pallets or in other bundled forms. Paper and paperboard require a high degree of care in handling as the product is very susceptible to breakage. Paper must also be kept dry and accordingly paper moved in covered hopper barges must be insulated by dunnage to prevent direct contact with the barge structure which may be wet with condensation. Newsprint has the same basic handling characteristics and requirements although it is relatively lower in value than paper and paperboard.

Each of the other commodities in this group have different handling requirements, however, due to the low volume of movements they will not be discussed here. In general, these other commodities are breakbulk in nature and are relatively high value per ton.

Movements of the Non-Durable Manufactures, NEC

The movements of the largest volume commodities have been described under their respective sections. As a group the general pattern of movements are very export-import oriented as evidenced by the lack of intrastate movements (see Exhibit XIX-4). Louisiana accounts for a high percent of both outbound and inbound movements as a result of the export-import orientation of the movements.

This group represents only one half of one percent of the total tonnage moved on the internal waterways in 1976. The group's movements increased in volume from 1969 to 1976 at an annual rate of 7.5 percent, however, it is evident from Exhibit XIX-5 that this growth was very volatile with the tonnage in 1975 falling to the 1969 level.

Exhibit XIX-4

NON-DURABLE MANUFACTURERS, NEC GROUP MOVEMENTS

1976

(short tons)

	Inbound	Outbound	Intrastate
Alabama	16,654	104,686	103,685
Arkansas	603	199,060	0
Illinois	53,849	188,187	34,847
Indiana	835	0	0
Iowa	4,599	127,186	0
Kansas	0	0	0
Kentucky	14,801	22,505	0
Louisiana	1,051,762	428,111	440,687
Minnesota	7,482	34,387	0
Mississippi	6,537	243,028	4,655
Missouri	4,984	87,018	0
Nebraska	4,817	4,239	0
Ohio	111,154	4,895	0
Oklahoma	5,199	0	0
Pennsylvania	5,724	4,229	0
Tennessee	65,124	57,790	0
West Virginia	0	0	0
Wisconsin	0	0	0
Total	1,348,925	1,505,321	583,874

Source: Temple, Barker & Sloane, Inc.

Exhibit XIX-5

NON-DURABLE MANUFACTURES NEC GROUP SHIPMENTS
1969-1976
(short tons)

	Inbound	Outbound	Intrastate	Total
1969	978,103	906,538	197,753	2,082,394
1970	1,461,930	1,341,513	191,974	2,995,417
1971	1,660,912	1,542,006	262,119	3,465,037
1972	1,309,511	1,440,870	379,613	3,129,994
1973	1,085,250	1,110,210	405,709	2,601,169
1974	1,142,848	1,271,221	400,541	2,814,610
1975	873,828	1,033,584	182,595	2,090,007
1976	1,348,925	1,505,321	583,874	3,438,120

Source: Temple, Barker & Sloane, Inc.

XX. COMMODITY GROUP 18 - DURABLE MANUFACTURES, NEC

This group includes the following U.S. Army Corps of Engineers commodity classifications:

0841	Crude Rubber and Allied Gums
1911	Ordnance and Accessories
2491	Wood Manufactures, NEC
2511	Furniture and Fixtures
2822	Synthetic Rubber
3011	Rubber and Miscellaneous Plastic Products
3211	Glass and Glass Products
3251	Structural Clay Products, including Refractories
3291	Miscellaneous Nonmetallic Mineral Products
3611	Electrical Machinery, Equipment and Supplies
3711	Motor Vehicles, Parts and Equipment
3721	Aircraft and Parts
3731	Ships and Boats
3791	Miscellaneous Transportation Equipment
3811	Instruments, Photographic and Optical Goods, Watches and Clocks
3911	Miscellaneous Products of Manufacturing

These commodities were grouped due to their commonality as outputs of the manufacturing sector. Their handling characteristics vary greatly due to the range of products included; however, they can all be classified as general cargo. As such, they have been matched with MarAd's terminal classification for general cargo.

Exhibit XX-1 shows the tonnage of each commodity moved on the inland waterways in 1976 and the percent of the total group those tons represent. The commodity classification ships and boats account for about 14 percent of the group with no other single commodity accounting for more than 10 percent. The commodity classification of Miscellaneous Products of Manufacturing account for almost 53 percent of the group; however, thousands of products comprise this category making it very difficult to explain the production areas and markets for the individual products and the resultant commodity flows.

The handling characteristics of Durable Manufactures, NEC are again, as diverse as the number of commodities. In general these commodities are relatively high in value as they have undergone a value added process in manufacturing. Being high valued cargos, special care is required in handling to preclude damages. By the same token some of the commodities could be damaged by the elements and therefore must be transported in enclosed barges. The commodity classification of ships and boats are generally floated and are not normally transported on or in barges.

Exhibit XX-2 shows the movements of the Durable Manufacturers, NEC group by state. The largest volume of movement occur in Louisiana and more specifically intrastate Louisiana. These movements occur mainly on the Atchafalaya River and the Lower Mississippi below New Orleans.

Exhibit XX-1

BREAKDOWN OF THE DURABLE MANUFACTURES,
NEC GROUP BY COMMODITY, TONS AND PERCENT

Commodity	Short Tons*	Percent*
Crude Rubber	0	0.0
Ordance	0	0.0
Wood Manufactures	12,294	0.6
Furniture	8,196	0.4
Synthetic Rubber	206,958	10.1
Rubber and Plastic Products	10,245	0.5
Glass and Glass Products	26,638	1.3
Structural Clay Products	155,730	7.6
Misc. Nonmetallic Mineral Products	141,387	6.9
Electrical Machinery	86,061	4.2
Motor Vehicles	24,589	1.2
Aircraft and Parts	2,049	0.1
Ships and Boats	284,823	13.9
Misc. Transportation Equipment	8,196	0.4
Instrucments	0	0.0
Misc. Products of Manufacturing	1,081,920	52.8
General Hardware	0	0.0
Plumbing, Heating & Sanitary Equip.	0	0.0
Total	2,049,091	100.0%

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

Exhibit XX-2

DURABLE MANUFACTURES NEC GROUP MOVEMENTS

1976

(short tons)

	Inbound	Outbound	Intrastate
Alabama	211,337	34,769	50,734
Arkansas	2,374	1,293	0
Illinois	13,104	68,714	2,372
Indiana	267	1,702	607
Iowa	0	0	0
Kansas	0	0	0
Kentucky	74,831	6,934	0
Louisiana	119,491	402,382	1,991,594
Minnesota	0	0	0
Mississippi	58,062	83,457	2,407
Missouri	5,259	5,851	0
Nebraska	0	0	0
Ohio	17,144	14,435	75
Oklahoma	0	915	0
Pennsylvania	21,435	3,628	0
Tennessee	46,992	84,406	1,302
West Virginia	4,984	5,068	0
Wisconsin	0	0	0
Total	575,280	713,554	2,049,091

Source: Temple, Barker & Sloane, Inc.

Exhibit XX-3 shows the aggregate shipments and receipts of the Manufactured Durables, NEC group for the years 1969-1976. The group experienced a 6.7 percent annual growth rate over this period. The growth rate was very erratic during the 1969-1976 period with the lowest volume occurring in 1974.

The Durable Manufacturers, NEC group accounts for .6 percent of the total tonnage moved on the inland waterways of the Mid-America region.

Exhibit XX-3

DURABLE MANUFACTURES NEC GROUP SHIPMENTS

1969-1976

(short tons)

	Inbound	Outbound	Intrastate	Total
1969	311,729	438,069	1,373,154	2,122,952
1970	286,309	450,021	1,376,295	2,112,625
1971	341,188	426,786	1,346,131	2,114,105
1972	277,838	406,752	1,180,054	1,864,644
1973	315,345	478,466	1,277,021	2,070,832
1974	301,232	392,206	1,329,344	1,329,344
1975	491,102	469,043	1,584,148	3,237,731
1976	575,280	713,554	2,049,091	3,337,925

Source: Temple, Barker & Sloane, Inc.

XXI. COMMODITY GROUP 19 - WASTE AND SCRAP, MISCELLANEOUS

The Waste and Scrap, Miscellaneous Group includes the following U.S. Army Corps of Engineers commodity classifications:

3312	Slag
4022	Textile Waste, Scrap and Sweepings
4024	Paper Waste and Scrap
4029	Waste and Scrap, NEC
4111	Water
4112	Miscellaneous Shipments, Unidentifiable by Commodity
4113	LCL Freight
9999	DOD Cargos

The scrap commodities included in this group account for approximately 89 percent of the total group with water accounting for over 10 percent of the balance (see Exhibit XXI-1).

The scrap, slag and water commodities can be characterized as very low in value and bulk in form. Water obviously is moved in a liquid form whereas scrap and waste and slag are transported in dry bulk form. They are normally transported in open hopper barges and do not require any special care in transit. These commodities are normally transferred with clamshell grabs.

Exhibit XXI-1

BREAKDOWN OF THE WASTE AND SCRAP MATERIALS,
MISCELLANEOUS GROUP BY COMMODITY TONS AND PERCENT

Commodity	Short Tons*	Percent*
Slag	785,709	14.8
Textile Waste	0	0.0
Paper Waste	0	0.0
Waste and Scrap, NEC	3,917,931	73.8
Water	541,502	10.2
Misc. Shipments, Unidentifiable by Commodity	63,706	1.2
LCL Freight	0	0.0
DOD Cargos	0	0.0
Total	5,308,850	100.0

*Numbers may not total due to rounding.

Percentages were obtained from Waterborne Commerce of the United States, 1976, Part 2, page 140. The tonnages were adjusted to reflect the boundaries of the 17 state Mid-America region.

The primary uses of waste/scrap and slag is as an aggregate or fill for construction projects and land reclaimation projects. This commodity group was matched with MarAd's terminal classification for the transfer of waste and scrap materials, miscellaneous.

The balance of this group, i.e. Miscellaneous Shipments, LCL Freight and DOD cargos, account for a very small portion of the total tonnage moved on the inland waterways. In 1976 no tonnage of the latter two commodities moved in the Mid-America Region. As this study is terminal oriented, LCL freight and DOD cargos were included with miscellaneous shipments as the terminal types required for these shipments are vastly different than those required for any other commodity group.

Exhibit XXI-2 shows the movements of the Waste and Scrap Materials, Miscellaneous Group by state. Illinois and Louisiana account for 90 percent of the total tons moved.

Exhibit XXI-3 shows the aggregate movements of the group for the period 1969-1976. Although the group has grown at an annual rate of 5.5 percent of the entire seven year period, the movements have been on a downward trend since 1974 after peaking at slightly over seven million tons. The Waste and Scrap Materials Group account for 1.2 percent of the total tonnage moved on the inland waterways in 1976.

Exhibit XXI-2

WASTE AND SCRAP MATERIALS GROUP MOVEMENTS

1976

(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	5,926	6,553	0
Arkansas	9,138	2,505	0
Illinois	17,350	79,525	2,160,547
Indiana	0	0	0
Iowa	0	0	0
Kansas	0	0	0
Kentucky	49,072	26,549	0
Louisiana	143,152	258,593	2,425,551
Minnesota	48,235	0	0
Mississippi	29,632	5,397	12,072
Missouri	95,822	1,670	0
Nebraska	0	0	0
Ohio	24,273	10,280	0
Oklahoma	22,297	0	0
Pennsyvlania	17,564	1,440	0
Tennessee	34,606	12,924	0
West Virginia	9,318	13,662	77,776
Wisconsin	0	55,623	0
Total	506,385	474,721	4,675,946

Source: Temple, Barker & Sloane, Inc.

Exhibit XXI-3

WASTE AND SCRAP MATERIALS GROUP SHIPMENTS
1969-1976
(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	336,928	469,818	3,085,507	3,892,253
1970	433,639	465,012	2,623,758	3,522,409
1971	667,179	441,158	2,889,317	3,997,654
1972	846,257	530,904	4,711,930	6,089,091
1973	585,572	458,583	4,482,172	5,526,327
1974	593,397	430,010	6,051,568	7,074,975
1975	481,336	321,728	6,039,547	6,842,611
1976	506,385	474,721	4,675,946	5,657,052

Source: Temple, Barker & Sloane, Inc.

XXII. COMMODITY GROUP 20 - WATERWAY IMPROVEMENT AND GOVERNMENT MATERIALS

The Waterway Improvement and Government Materials Group includes only one U.S. Army Corps of Engineers commodity classification:

4811 Materials Used in Waterway Improvement, Government Materials

The largest volume of movements in this group is accounted for by material dredged from the bottom of the rivers and transported to other areas where it is dumped for fill or to strengthen river embankments.

These operations are carried out by the U.S. Army Corps of Engineers, and the vessels utilized in these operations are owned and operated by the U.S. Army Corps of Engineers. Other materials transported on the waterways for improvements include pilings, rock, and cement forms used as riprap.

Exhibit XXII-1 shows the movements of Waterway Improvement and Government Materials by state. The largest volume of movements occurred in Kentucky where over 3.1 million tons of Waterway Improvement materials were moved out of the Cumberland and Tennessee Rivers. Substantial movements of this group also occurred on the Missouri River. These movements were both outbound and intrastate. The vast majority of the waterway improvement materials that were removed from these areas were transported to the Lower Mississippi River where they were used in Louisiana and Mississippi.

Exhibit XXII-1

WATERWAY IMPROVEMENT
AND GOVERNMENT MATERIALS MOVEMENTS

1976
(Short Tons)

	Inbound	Outbound	Intrastate
Alabama	4,800	0	0
Arkansas	128,715	157,501	407,222
Illinois	197,881	6,000	140,297
Indiana	1,892	605	0
Iowa	200	49,883	32,889
Kansas	0	45,436	0
Kentucky	21,923	3,135,753	382,020
Louisiana	2,012,917	30,469	868,947
Minnesota	0	0	0
Mississippi	1,191,819	218,246	131,507
Missouri	146,246	880,993	578,485
Nebraska	200	200	0
Ohio	0	0	0
Oklahoma	0	2,470	28,200
Pennsylvania	0	5,098	0
Tennessee	922,465	62,539	117,094
West Virginia	71	0	0
Wisconsin	0	0	0
Total	4,629,129	4,595,193	2,686,661

Source: Temple, Barker & Sloane, Inc.

Exhibit XXII-2 shows the aggregate movements of the Waterway Improvement and Government Materials Group for the period 1969-1976. The volume of movements has fluctuated greatly from year to year. Much of the volume depends on the work required each year to maintain the river embankments from eroding further. In years when the high waters are extremely destructive, more maintenance and rebuilding is required to prevent further destruction the following year. Because of the nature of the demand for their movements, projections of future growth are very difficult to make.

In 1976 this group represented 1.7 percent of the total tonnage moved on the internal waterways of the Mid-America region.

Exhibit XXII-2

WATERWAY IMPROVEMENT AND GOVERNMENT MATERIALS SHIPMENTS

1969-1976

(Short Tons)

	Inbound	Outbound	Intrastate	Total
1969	5,308,670	5,240,148	2,274,380	12,823,198
1970	5,180,335	5,329,586	3,527,712	14,037,673
1971	4,976,092	5,111,836	3,126,108	13,214,036
1972	4,259,549	4,372,936	3,465,050	12,097,535
1973	6,050,801	6,183,899	3,115,575	15,451,275
1974	6,238,575	6,446,294	5,442,427	18,127,296
1975	4,912,996	4,937,154	3,525,079	13,375,229
1976	4,629,129	4,595,193	2,686,661	11,910,983

Source: Temple, Barker & Sloane, Inc.

MID-AMERICA PORTS STUDY

APPENDIX B

PORT FACILITIES INVENTORY FORM

APPENDIX B
PORT FACILITIES INVENTORY FORM

This appendix shows the survey form used in conducting the inventory of terminal facilities. Accompanying the form are the instructions which were provided to help respondents complete the form, and the Port Facility Inventory Code Sheet. The latter defines alphanumeric codes which were used in the inventory and can be used to interpret the Facility Inventory Data tabulated in Appendix I.

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/
Updat Cd- _/_/
FOR HARAD USE ONLY

PORT FACILITIES INVENTORY

I. General Port and Terminal Data

As Of Date-
006 _/_/_/_/_/_/

Port Name-
003 _/_/_/_/_/_

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/_/
Updat Cd- _/_/
FOR MARAD USE ONLY

11. Pier Data

Pier Name- 029 _/

Vessel Types- 030 _/_/_/_/_/

Vessel DWT- 031 _/_/_/

Cargo Types- 032 _/_/_/_/_/

Pier Structure Type- 033 _/

Substructure Const. Materials 034 _/_/_/_/_/

Pier Const. Materials- 035 _/_/_/_/_/

Apron Const. Materials- 036 _/_/_/

Pier*	Face/End **	Side 1	Side 2
Length-	037 _/_/_/_/	038 _/_/_/_/	039 _/_/_/_/
Min. Depth-	040 _/_/_/	041 _/_/_/	042 _/_/_/
No. of Vessels-	043 _/	044 _/	045 _/
Vessel Length-	046 _/_/_/_/	047 _/_/_/_/	048 _/_/_/_/
Slip Width-	049 _/_/_/	050 _/_/_/	051 _/_/_/
Deck Height-	052 _/_/	053 _/_/	054 _/_/
Deck Width-	055 _/_/_/	056 _/_/_/	057 _/_/_/
Load Capacity (psf)-	058 _/_/_/_/	059 _/_/_/_/	060 _/_/_/_/
Truck/Rail Access-	061 _/	062 _/	063 _/

* Enter data in the appropriate column (s).

** For wharves and quays paralleling the river bank enter pier data under column headed by Face/End.

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/_/
Updat Cd- _/_/
FOR MARAD USE ONLY

General Cargo/Container/RO-RO/LASH-SEABEE Facilities

Storage:	Area 1	Area 2	Area 3	Area 4
Const. Materials-	123 _/_/_/_/_/	124 _/_/_/_/_/	125 _/_/_/_/_/	126 _/_/_/_/_/
Inside Storage-	127 _/_/_/_/	128 _/_/_/_/	129 _/_/_/_/	130 _/_/_/_/
Reefer Storage-	131 _/_/_/_/	132 _/_/_/_/	133 _/_/_/_/	134 _/_/_/_/
Yard Storage-	135 _/_/_/	136 _/_/_/	137 _/_/_/	138 _/_/_/
Inside Stack Ht.-	139 _/_/	140 _/_/	141 _/_/	142 _/_/
Load Capacity 1-	143 _/_/_/_/	144 _/_/_/_/	145 _/_/_/_/	146 _/_/_/_/
Load Capacity 2-	147 _/_/_/_/	148 _/_/_/_/	149 _/_/_/_/	150 _/_/_/_/
Truck/Rail Access-	151 _/	152 _/	153 _/	154 _/

Handling Equipment:	Group 1	Group 2	Group 3	Group 4	Group 5
Type-	166 _/	167 _/	168 _/	169 _/	170 _/
Number-	173 _/_/	174 _/_/	175 _/_/	176 _/_/	177 _/_/
Capacity-	180 _/_/_/	181 _/_/_/	182 _/_/_/	183 _/_/_/	184 _/_/_/
Fixed/Moveable-	187 _/	188 _/	189 _/	190 _/	191 _/
Outreach-	194 _/_/_/	195 _/_/_/	196 _/_/_/	197 _/_/_/	198 _/_/_/
Container Sizes-	201 _/_/	202 _/_/	203 _/_/	204 _/_/	205 _/_/
Cycle Time-	208 _/_/_/	209 _/_/_/	210 _/_/_/	211 _/_/_/	212 _/_/_/
Stack Height-	215 _/_/	216 _/_/	217 _/_/	218 _/_/	219 _/_/

Remarks Section-
243 _/_/_/_/_

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/_/
Updat Cd- _/_/
FOR HARAD USE ONLY

Dry Bulk Terminal Facilities

Storage:	Area 1	Area 2	Area 3
Outside Storage (A)-	244 _/_/_/	245 _/_/_/	246 _/_/_/
Outside Storage (LT)-	247 _/_/_/_/_/	248 _/_/_/_/_/	249 _/_/_/_/_/
Inside Storage (LT)-	250 _/_/_/_/	251 _/_/_/_/	252 _/_/_/_/
Inside Storage (SF)-	253 _/_/_/_/	254 _/_/_/_/	255 _/_/_/_/
Inside Storage (CF)-	256 _/_/_/_/	257 _/_/_/_/	258 _/_/_/_/
Storage Construction-	259 _/_/_/_/_/	260 _/_/_/_/_/	261 _/_/_/_/_/
Truck/Rail Access-	262 _/	263 _/	264 _/

Handling Equipment:	Group 1	Group 2	Group 3
Type-	268 _/	269 _/	270 _/
Number-	271 _/_/	272 _/_/	273 _/_/
Capacity-	274 _/_/_/_/_/	275 _/_/_/_/_/	276 _/_/_/_/_/
Loading Rate-	277 _/_/_/_/_/	278 _/_/_/_/_/	279 _/_/_/_/_/
Discharge Rate-	280 _/_/_/_/_/	281 _/_/_/_/_/	282 _/_/_/_/_/
Outreach-	283 _/_/_/	284 _/_/_/	285 _/_/_/
Fixed/Moveable-	286 _/	287 _/	288 _/

Remarks Section-
292 _/_/_/_/_

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/_/
Updat Cd- _/_/

FOR MARAD USE ONLY

VI. Liquid Bulk Terminal Facilities

Storage:	Area 1	Area 2	Area 3
Storage Construction-	293 _/_/_/_/_/	294 _/_/_/_/_/	295 _/_/_/_/_/
Storage Number-	296 _/_/_/	297 _/_/_/	298 _/_/_/
Storage Capacity-	299 _/_/_/_/	300 _/_/_/_/	301 _/_/_/_/
Surface/Subsurface-	302 _/	303 _/	304 _/
Truck/Rail Access-	305 _/	306 _/	307 _/

Handling Equipment:	Group 1	Group 2	Group 3
Equip. Services-	314 _/	315 _/	316 _/
Transfer Method-	317 _/	318 _/	319 _/
Loading Rate-	320 _/_/_/_/	321 _/_/_/_/	322 _/_/_/_/
Discharge Rate-	323 _/_/_/_/	324 _/_/_/_/	325 _/_/_/_/

COE Port Cd- _/_/_/_/_/
Term Cd- _/_/_/_/
Updat Cd- _/_/

FOR MARAD USE ONLY

VII. Bulk Grain Terminal Facilities

Storage:	Area 1	Area 2	Area 3
Storage Construction-	332 _/_/_/_/_/	333 _/_/_/_/_/	334 _/_/_/_/_/
Storage Capacity-	335 _/_/_/_/_/	336 _/_/_/_/_/	337 _/_/_/_/_/
Truck/Rail Access-	341 _/	342 _/	343 _/

Handling Equipment:	Group 1	Group 2	Group 3
Type-	347 _/	348 _/	349 _/
Number-	350 _/_/	351 _/_/	352 _/_/
Fixed/Moveable-	353 _/	354 _/	355 _/
Spout Height-	356 _/_/	357 _/_/	358 _/_/
Outreach-	359 _/_/_/	360 _/_/_/	361 _/_/_/
Loading Rate-	362 _/_/_/	363 _/_/_/	364 _/_/_/
Discharge Rate-	365 _/_/_/	366 _/_/_/	367 _/_/_/

Remarks Section-
374 _/_/_/_/_

PORT FACILITIES INVENTORY INSTRUCTIONS

General

Before proceeding to the specific instructions a few general comments are in order.

1) Each data element is identified by a three digit data number and has a specific number of spaces in which the information is to be placed. This number can not be exceeded, however, standard abbreviations may be used.

2) Be sure that answers are expressed in the unit of measure given in the instructions.

3) The use of the headings "Area" and "Group" permit the inclusion of multiple storage (AREA) facilities and handling equipment (GROUP) types for a particular facility.

4) Refer to attached code sheet for those items in the instructions requiring codes.

If questions concerning the use of the inventory form develop contact:

William W. Dean
Maritime Administration
Department of Commerce Room 4896
14th and E Streets, N.W.
Washington, D.C. 20230
Tel. 202/377-2277

Instructions

I. General Port and Terminal Data

Data No.	Data Element	
006	As of Date	: Date survey completed expressed numerically - mo/day/yr
003	Port Name	: Name of port in which facility is located.
008	Terminal Name	: Official name of terminal in which facility is located.
009	Address	: Terminal street address (mailing address)

Data No.	Data Element		
010	City	:	Name of terminal city.
011	State	:	Terminal state.
012	Zip	:	Terminal zip code.
013	Owner Name	:	Name of terminal owner (Enter "Same" if owner and terminal name and address are the same).
014	Address	:	Owner's street address (mailing address)
015	City	:	Name of owner city.
016	State	:	Owner state.
017	Zip	:	Owner zip code.
019	Operator Name and Address	:	Name and mailing address of the first operator using terminal (Enter "Same" if owner and operator name and address are the same).
020		:	If applicable, name and address of second operator using terminal.
021		:	If applicable, name and address of third operator using terminal.
383	River Name	:	Enter river on which terminal is located (see Code #1).
384	River Mile	:	Enter river mile at which terminal is located.
385	Bank Location	:	See Code #2.
018	Classification	:	See Code #3.
027	Condition	:	See Code #4.
028	Channel Depth	:	Enter minimum channel depth in feet.
026	Cargo System	:	Enter in third space (1) if primary cargo system (2) if secondary cargo system (Note: At a given facility, primary cargo systems may operate simultaneously, but a secondary system must replace a primary to operate).

Data No.	Data Element		
386	Current Velocity (high)	:	Enter approximate average high current for river in knots.
387	Current Velocity (low)	:	Same as above, but approximate average low current.
388	Working Days Lost (current)	:	Enter number of working days lost due to excessive current.
389	Working Days Lost (river stage)	:	Enter number of working days lost due to high or low water.

II. Fleeting Area Data

Data No.	Data Element		
390-391	Barge Capacity	:	Enter maximum number of barges (use a 190' X 35' barge as a standard).
392-393	Mooring Type	:	See Code #5.

III. Pier Data

Data No.	Data Element		
029	Pier Name	:	Enter local name or identification of pier.
030	Vessel Types	:	Enter types of vessels using facility (see Code #6).
031	Vessel DWT	:	Enter deadweight tonnage of largest vessel that can be accommodated in 1,000's of tons.
032	Cargo Types	:	Enter types of cargo handled (see Code #7).
033	Pier Structure Type	:	See Code #8.
034	Substructure Const. Materials	:	See Code #9.
035	Pier Const. Materials	:	See Code #9.
036	Apron Const. Materials	:	See Code #9.
037-039	Length	:	Enter length in feet.
040-042	Minimum Depth	:	Enter in feet minimum design depth alongside at low water datum.

Data No.	Data Element		
043-045	Number of Vessels	:	Enter number of vessels which can be berthed simultaneously.
046-048	Vessel Length	:	Length of Vessel in feet - (see above).
049-051	Slip Width	:	Minimum slip width in feet.
052-054	Deck Height	:	Height of deck in feet above water at low water datum.
055-057	Deck Width	:	Minimum width of pier deck and apron in feet.
058-060	Load Capacity	:	Maximum load deck and apron can support in pounds per square foot.
061-063	Truck/Rail Access	:	See Code #10.

IV. General Cargo/Container/Ro-Ro/Lash-Seabee Facilities

Data No.	Data Element		
Storage:			
123-126	Const. Materials	:	See Code #9.
127-130	Inside Storage	:	Area of sheds, warehouses in 1,000's of square feet.
131-134	Reefer Storage	:	Refrigerated storage in 1,000's of cubic feet.
135-138	Yard Storage	:	Enter number of acres of back-up area.
139-142	Inside Stack Ht.	:	Maximum vertical distance cargo can be stacked in sheds in feet.
143-146	Load Capacity 1	:	Maximum floor load in pounds per square foot (first floor).
147-150	Load Capacity 2	:	Same as above (2nd floor).
151-154	Truck/Rail Access	:	See Code #10.

Data No.	Data Element		
Handling Equipment:			
166-170	Type	:	See Code #11 for equipment types.
173-177	Number	:	Enter number of pieces in each group.
180-184	Capacity	:	Enter manufacturer's maximum safe working load in long tons.
187-191	Fixed/Movable	:	Enter (F) if equipment is fixed Enter (M) if equipment is movable
194-198	Outreach	:	Enter maximum overhang of boom over water in feet.
201-205	Container Sizes	:	See Code #12 for container sizes handled.
208-212	Cycle Time	:	Enter equipment cycle time in feet of wire rope per minute.
215-219	Stack Height	:	Enter maximum height containers can be stacked in feet (assume 8' container height).
243	Remarks Section	:	Enter comments or explanation relative to specific fields in this section.

V. Dry Bulk Terminal Facilities

Data No.	Data Elements		
Storage:			
244-246	Outside Storage (A)	:	Enter number of acres of outside storage.
247-249	Outside Storage (LT)	:	Enter outside storage in 1,000's of long tons.
250-252	Inside Storage (LT)	:	Enter inside storage in 1,000's of long tons.
253-255	Inside Storage (SF)	:	Enter inside storage in 1,000's of square feet.

Data No.	Data Element		
256-258	Inside Storage (CF)	:	Enter inside storage in 1,000's of cubic feet.
259-261	Storage Construction	:	See Code #9-include materials used for inside and outside storage.
262-264	Truck/Rail Access	:	See Code #10.
Handling Equipment:			
268-270	Type	:	See Code #11 for equipment types.
271-273	Number	:	Enter number of pieces in each group.
274-276	Capacity	:	Enter manufacturer's maximum safe working load in long tons.
277-279	Loading Rate	:	Enter equipment loading rate in long tons per hour.
280-282	Discharge Rate	:	Enter equipment discharge rate in long tons per hour.
283-285	Outreach	:	Enter maximum overhang of boom over water in feet.
286-288	Fixed/Movable	:	Enter (F) if equipment is fixed. Enter (M) if equipment is movable.
292	Remarks Section	:	Enter comments or explanations relative to specific fields in this section.

VI. Liquid Bulk Terminal Facilities

Data No.	Data Elements		
Storage:			
293-295	Storage Construction	:	See Code #9.
296-298	Storage Number	:	Enter number of storage tanks.
299-301	Storage Capacity	:	Enter total storage capacity for liquid bulk in 1,000's of barrels.
302-304	Surface/Subsurface	:	Enter (A) if facilities above ground. Enter (B) if facilities completely below ground. Enter (C) if facilities combination.

Data No.	Data Element		
305-307	Truck/Rail Access	:	See Code #10.
Handling Equipment:			
314-316	Equipment Services	:	Enter: (R)-Refinery only (P)-Plant only (D)-Distribution Terminal only (A)-All three above (X)-Refinery and Plant (Y)-Refinery and Distribution Terminal (Z)-Plant and Distribution Terminal
317-319	Transfer Method	:	Enter: (C)-Conventional Cargo Hoses (M)-Other Mechanical Connector (B)-Both Methods Blank-Neither Method
320-322	Loading Rate	:	Enter in 100's of barrels per hour.
323-325	Discharge Rate	:	Same as above.

VII. Bulk Grain Terminal Facilities

Data No.	Data Element		
Storage:			
332-334	Storage Construction	:	See Code #9.
335-337	Storage Capacity	:	Enter total storage capacity for grain in 1,000's of bushels.
341-343	Truck/Rail Access	:	See Code #10.
Handling Equipment:			
347-349	Type	:	See Code #11 for equipment types.
350-352	Number	:	Enter number of pieces in each group.
353-355	Fixed/Movable	:	Enter (F) if equipment is fixed. Enter (M) if equipment is movable.

Data No.	Data Element		
356-358	Spout Height	:	Enter maximum vertical distance from water to lowest extremity of spout or chute given in feet.
359-361	Outreach	:	Enter maximum overhang of equipment over water in feet.
362-364	Loading Rate	:	Enter in 1,000's of bushels per hour.
365-367	Discharge Rate	:	Same as above.
374	Remarks Section	:	Enter comments or explanations relative to specific fields in this section.
375	General Remarks	:	Enter comments or explanations relative to the total facility not covered in previous remarks sections.
376	General Remarks	:	Continuation of #375 if required.

1. River Code: 383
(select one code)

River Name	River Code
Allegheny River	AG
Alabama and Coosa Rivers, AL	AL
Apalachicola/Chattahoochee/Flint	AP
Atchafalaya River	AT
Bayou Terrebonne, LA	BA
Bayou Barataria	BB
Bayou LaFourche, LA	BL
Blackwater River, FL	BR
Bayou Teche, LA	BT
Black Warrior and Tombigbee Rivers	BW
Calcasieu River and Pass, Lake Charles, LA	CA
Chicago Sanitary and Ship Canal	CC
Channel to Aransas Pass, TX	CH
Clinch and Emory Rivers, TN	CI
Channel to Arroyo Colorado, TX	CL
Corpus Christi Ship Channel	CO
Channel to Palacios, TX	CP
Channel to Rockport, TX	CR
Calumet SAG Channel	CS
Cumberland River	CU
Freshwater Bayou	FB
Green River and Barren Rivers, KY	GB
Gulf Coast	GC
GIWW	GI
Gulf County Canal	GU
Hiwassee River, TN	HI
Houston Ship Canal	HS
Inner Harbor Navigation Canal	IH
Illinois Waterway	IL
Kentucky River	KY
Kanawha River	KA
Lake Erie	LE
Lake Huron	LH
Lake Michigan	LM
Lake Ontario	LO
Lake Pontchartrain	LP
Lake Superior	LS
Matagorda Ship Canal, TX	MA
Minnesota River, MN	ME
Mississippi River Gulf Outlet	MG
Mississippi River	MI

River Name	River Code
McClellan-Kerr Arkansas River Navigation System	MK
Monongahela River	MN
Mermentau River Bayous Nezpique and Des Cannes, LA	MR
Mobil Ship Canal	MS
Missouri River	MO
Neches River	NR
Ouachita and Black Rivers	OB
Ouachita River Above Camden, AR	OB
Ohio River	OH
Port Allen to Morgan City Alternate Route	PA
Pearl River (East)	PE
Pearl River (West)	PR
Petit Anse Tigre and Carlin Bayous, LA	PT
Sabine River and Harbor	SA
San Bernard River, TX	SB
St. Croix River, WI and MN	SC
Texas City Channel	TC
Tennessee River	TN
Trinity River Channel to Liberty, TX	TR
Tennessee-Tombigbee Waterway	TT
Vermilion Bayou	VB
Yazoo River Mouth, Vicksburg	YA
Yazoo River, MS	YA

---

2. Bank Location Code: 385
(select one code)

A. Left Descending
B. Right Descending
C. Near Crossing
D. Current Bank
E. Lee Bank

---

3. Classification Code: 018
(select one code)

A. U.S. Government
B. Public (state, city, local)
C. Private
D. Pre-allocated - DOD

---

4. Condition Code: 027
(select one code)

A. Good
B. Fair
C. Poor
D. Under Construction
E. Destroyed

---

5. Mooring Type Code: 392,393
(select one code)

A. Anchor
B. Bank
O. Other

6. Vessel Type Code: 030
(select up to five codes)

A. Tanker
B. General Cargo
C. Container
D. RO/RO
E. LASH or SEABEE
F. OBO (ore,bulk,oil)
G. Passenger
H. Passenger/Freighter
I. Dry Bulk
J. Liquefied Natural and Propane Gas Carriers
K. Specialized Liquid Chemical Carrier
L. Refrigerated
M. Other
N. Barges
O. Self Unloading Barges
P. Not in use
Q. Tug and Barge Mooring
R. Winter Mooring
S. Vessel Repairs
T. Self Unloading Vessels

---

7. Cargo Type Code: 032
(select up to five codes)

A. General Cargo Only
B. Passenger/General Cargo
C. Passenger Only
D. Wood and Wood Products
E. Coal and Coke Products
F. Ores and Concentrates
G. Non-metallic Minerals (sand, gravel, rock, brick, clays, earth, gypsum, salt, dry sulfur, cement, limestone)
H. Iron, Steel, and Mill Products
I. Fertilizers (nitrates, phosphates, potash)
J. Crude Petroleum
K. Refined Petroleum Products
L. Liquefied Natural Gas
M. Liquefied Propane Gas
N. Liquid Bulk Ores (nickel, cobalt, Sulphides)
O. Grain
P. Bulk Raw Sugar
Q. Bauxite and Aluminum Ores
R. Liquefied Chemicals and Allied Products
S. Other
T. Molasses
U. Caustic Soda
V. Scrap Metal
W. Refrigerated

---

8. Structure Type Code: 033
(select one code)

A. Wharf- marginal
B. Wharf- wooden bulkhead
C. Wharf- retaining wall other than wood
D. Wharf- offshore
E. Wharf- pontoon
F. Wharf- other
G. Pier- finger
H. Pier- T-head
I. Pier- L-head
J. Pier- irregular shape
K. Pier- mooring dolphins w/floating platform
L. Pier- other
M. Single point mooring
N. Other
O. Submarine pipeline

---

9. Construction Material Code: 034-036, 123-126, 259-261, 293-295, 332-334
(select up to three or five codes as appropriate)

A. Aluminum
B. Corrugated Aluminum
C. Asbestos
D. Pre-cast Concrete
E. Concrete
F. Steel
G. Corrugated Steel
H. Metals Other Than Steel
I. Wood
J. Brick, Cobblestone, Cinder Block
K. Asphalt
L. Fill (impacted earth, sand, gravel, rock, etc.)
M. Steel Frame
N. Wooden Frame
O. Metal Frame Other Than Steel
P. Concrete Frame
Q. Reinforced Concrete Frame
R. Other

---

10. Truck/Rail/Pipeline Access Code: 061-063, 151-154, 262-264, 305-307, 341-343
(select one code or leave blank)

R. Rail Only
T. Truck Only
P. Pipeline Only
B. Both Rail and Truck
C. Both Rail and Pipeline
D. Both Truck and Pipeline
E. All
BLANK - None

---

11. Handling Equipment Type Code: 166-170, 268-270, 347-349
(select one code per Group)

A. General Cargo/Container Crane
B. Container Crane
C. Straddle Carrier
D. Piggy-Packer
E. Lift Truck with Spreader
F. Transtainer
G. Yard Crane - Other
H. Shiploader-slewing chute, gravity loader, conveyor belt feed
I. Gantry Crane Unloader w/Single Bucket
J. Pneumatic Loader
K. Pneumatic Unloader
L. Marine Leg (continuous bucket)
M. Gravity Chute Loading Spout
N. Other
O. Hulet
P. Locomotive Crane
Q. Front End Loader
R. Timber Carrier
S. Crane w/Magnet
T. Crane-Clam Shell Bucket
U. Bridge Crane
V. Bulldozer
W. Conveyor Belt System
X. Fork Lifts
Y. Shoreside RO/RO Ramp
Z. Reclaimer
2. Auger
3. Whipline

---

12. Container Handling Code: 201-205
(select up to two codes)

A. Two 20 footers simultaneously
B. Single 20 footer
C. 24 footer
D. 27 footer
E. 30 footer
F. 35 footer
G. 40 footer
H. Other
I. A, B, F, G
J. A, B, G
K. B, F, G
L. C, D, E
M. B, C, G
N. B, E, D
O. C, D, G
P. C thru G
Q. ALL
R. B thru H

13. Terminal Type Code: 025
(select up to five codes)

A. General Cargo
B. Container
C. LASH/SEABEE
D. Ro/Ro
E. Dry Bulk
F. Liquid Bulk
G. LNG
H. LPG
J. Bulk Grain
K. Repair Facilities
L. Automobile
M. Passenger
N. Barge Ferry
P. Other (Specify exact type in remarks section data element #375 or 376)
X. Special Marad Designator (For Marad Use Only)
Y. "
Z. "

14. Equipment - Fixed/Moveable Code: 187-193,286-288,353-355

F - Fixed
M - Moveable

15. Container Stacking Height Code: 398

1 - 1 high
2 - 2 high
3 - 3 high
4 - 4 high
C - On chassis

16. Boom Code: 407-413

F - Fixed boom does not "Top Up"
C - "Tops Up" and clears pier face
D - "Tops Up" but does not clear pier face
N - Not applicable

17. Liquid Bulk Storage Code: 302-304

A - Above ground
B - Completely below ground
C - Combination

18. Liquid Bulk Equipment Services: 314-316

R - Refinery only
P - Plant only
D - Distribution Terminal only
A - All
X - Refinery and Plant
Y - Refinery and Distribution Terminal
Z - Plant and Distribution Terminal

19. Liquid Bulk Equipment Transfer: 317-319

C - Conventional Cargo Hoses
M - Other Mechical Connectors
B- Both

20. Storage Capacity Type Code: 423-425

B - Barrels
L - Long Tons

21. Equipment Capacity Type Code: 426-428

B - Barrels
L - Long Tons

MID-AMERICA PORTS STUDY

APPENDIX C

INLAND WATERWAY FLEET TECHNOLOGY

INLAND WATERWAY FLEET TECHNOLOGY

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Inland Waterway Fleet Technology

A. OVERVIEW

Providing the nation's lowest cost transportation for liquid and dry bulk commodities, the inland waterway fleet has successfully maintained its competitive position relative to alternative modes of transportation through successfully meeting challenges posed to the industry. The nature of future challenges to the inland waterways fleet will, however, be different from those of the past. These challenges will largely result from changes in regulatory policy, its associated costs, and delay in improvements to the waterways to accommodate future freight traffic.

The higher costs that the inland fleet may incur through fuel taxes, delays, and prospective user charges demand a continuation of the technical progress on the waterways since the post-World War II conversion of the fleet from steam to diesel propulsion and from small rivetted barges to large all-welded integrated flotillas. The technology of inland shipping will become an increasingly important opportunity and constraint upon the ability of the fleet to maintain its favorable position relative to alternative modes.

Commercial waterway navigation is dominated by the movement of towboats and barges and since the early 1900s, only a handful of self-propelled cargo vessels have been in operation. The development of towboats and barges has, and will continue to be characterized by refinements in design and not by revolutionary breakthroughs. The restrictions imposed by river and channel depths, breadth, current, river banks, the sizes of

locks through which tows must pass, and the need for commonality and interchangeability for efficient operations do not support rapid or radical technical change.

Technology on the rivers reflects decades of refinement by shipyards and fleet operators alike. The more than 1,400 towboats exceeding 100 gross tons and 16,000 barges exceeding 400 gross tons built between 1950 and 1976 for the inland waterway system have led to clear definitions of the attributes necessary for successful river operations and generally accepted guidelines for inland waterways equipment design and construction. This common experience, shaped by the unique restrictions and limitations of inland navigation is the reason that the more than 700 barge and towboat owners and operators have a view of future technological developments that is more consistent than most sectors of maritime commerce.

Exhibit 1 presents a sample of 82 transportation lines that accounted for roughly three-quarters of Mississippi River System and Gulf Intracoastal Waterway towboat power and barge capacity in 1975. The eleven Class 1 common and contract ICC regulated carriers listed operate an average of more than 350 barges each. Exhibit 2 summarizes the sample data.

This description of the inland fleet forms the background for an analysis of past and future development of the waterways fleet basic components: towboats; barges; and unconventional inland waterway technology.

Exhibit 1

SELECTED TRANSPORTATION LINES
MISSISSIPPI RIVER SYSTEM AND GULF INTRACOASTAL WATERWAY
1975

Operator	Service Areas or Limits	Key Commodity	Service	Towboats	Total HP (000)	Total Barges	Deck	Hopper	Tank
Agri-Trans Corporation	Mississippi	Dry Bulk	2	4	16.4	-	-	-	-
Aiple Towing Company	Gulf/Mississippi	Bulk	2	2	5.1	290	-	290	-
Alamo	GIW to Louisiana	Liquid Bulk	2	15	26.8	49	-	-	49
Allied Chemical Transportation	Miss/Ohio	Chem	3	1	0.4	74	-	59	15
Alter Company	Miss/Ohio	Bulk	2	8	22.3	187	-	187	-
American Commercial Barge	Inland Waterways	Bulk	1	20	74.3	1059	-	956	103
American River Lines	GIW/Mississippi	Charter	2	4	27.0	377	-	377	-
Amherst Industries	Kanawha/Ohio	Bulk	2	1	0.8	69	-	69	-
Arrow Transportation Company	Tenn/Miss/Ohio	Bulk	1	5	8.8	112	-	112	-
Ashland Oil	Gulf/Miss/Ohio	Oils	3	6	25.1	130	-	-	130
Brent Companies	GIW/Mississippi	Liquid	2	9	27.0	30	-	-	30
Bunge Corporation	Miss/Tributaries	Grain	2	1	3.1	191	-	191	-
Campbell Barge Line	Allegh/Monong/Ohio	Bulk	2	7	7.6	52	-	52	-
Canal Barge Company	GIW/Mississippi	Liquid	2	16	53.3	85	-	-	85
Cargo Carriers	Mississippi	Grain	2	4	16.6	230	-	228	2
Cenac Towing	GIW/Inland	Bulk	2	29	19.9	92	11	-	81
Central Soya Company	GIW/Mississippi	Dry Bulk	2	0	0.0	212	-	212	-
Chotin	GIW/Mississippi	Bulk	2	16	63.4	195	-		195
Consolidation Coal	Ohio, W.Va Area, All, Mono	Bulk	2	2	0.5	251	-	251	-

Key to Service Column: 1 = Common or Contract ICC-Regulated Carrier
2 = Exempt, For Hire Carrier
3 = Private Carrier

Service Areas: GIW = Gulf Intracoastal Waterway
Miss = Mississippi River
Monong, Mono = Monongahela River
Allegh, All = Allegheny River
Tenn = Tennessee River
Kana = Kanawha River
Blk = Black River
Mo = Missouri

Operator	Service Areas or Limits	Key Commodity	Service	Towboats	Total HP (000)	Total Barges	Deck	Hopper	Tank
Consolidated Grain & Barge	Miss R./Tributaries	Grain	2	0	0.0	166	-	166	-
Continental Navigation	Inland Wtrways	Bulk	2	2	1.7	99	-	99	-
Crain Brothers	All/Mono/Ohio R.	Bulk/Const.	2	10	7.7	98	-	98	-
Crounse	Miss/Oh/Ten/ Cumb/Green/Kana	Bulk	2	24	43.7	362	-	362	-
Daulton	Miss/Trib/Coast Wtrways	Charter	2	0	0.0	75	75	-	-
Dravo Corp	All/Mono/Ohio R, Neville Island	Sand/ Gravel	2/3	10	4.5	285	161	24	100
Exxon (Mid-America Region)	GIW of La, Tex, Miss.	Bulk	3	20	30.2	153	76	-	77
Federal Barge Line	GIW/Miss/ Tomb/Warrior	Bulk/ Package	1	6	37.6	35	-	35	-
Gladders	Gulf I/Miss R. System	Petrol/ Chemical	2	4	19.7	14	-	14	-
Gulf Oil	GIW/G. Mex/ Miss. River	Pet/Chem Oilwell Eq.	2	27	30.5	13	4	9	-
Hillman	Alleg/Mono/Ohio River	Bulk/ Oil	2	2	0.4	192	-	192	-
Hougland	GIW/Miss.	Pet/Coal	2	5	9.4	32	-	27	5
Indiana & Michigan Electric	Green/Kana/ Mono/Ohio River	Bulk	2	12	21.6	269	-	269	-
Ingram Barge Company	GIW, Cumb, Ill, Miss, Oh/Tenn R.	Pet/Prod	2	10	36.9	90	40	-	50
Inland Oil & Transport Co.	GIW, Miss	Liquid	2	9	33.7	39	-	-	39
Inland Tug Company	Mono/Oh., Pitts. Pa to Lan, Ind.	-	2	29	103.8	-	-	-	-
International Paper Company	Miss/Red/Blk/ Ohio/Ya300	Pulp/Log	3	3	2.7	39	31	1	1

Operator	Service Areas or Limits	Key Commodity	Service	Towboats	Total HP (000)	Total Barges	Deck	Hopper	Tank
Jones & Laughlin Steel	Alle/Mono/Ohio	Bulk	3	8	7.2	306	-	288	18
Jordan, Thomas Inc.	GIW/Miss/ Lake Point/Bayous	Charter	2	1	0.3	54	49	-	5
LaCrose Dredging	Miss/Ill/Missouri Ark Rivers	Towing/Pipe	3	7	1.3	20	7	11	2
Lake Charles Dredging	GIW/Inland	Towing/Shells	3	7	6.0	36	36	-	-
M/G Transport Co.	GIW, Miss, Ohio Rivers	Bulk Chem/Pet	2	11	27.7	240	-	226	14
Marine Transport Co.	GIW/Miss/Ohio/ Ill	Petrol	2	3	12.3	13	-	-	13
Mcalister Construction	Miss.	Gravel/Sand Construct.	3	9	7.8	49	49	-	-
McDonough Marine Service	Inland of LA, GIW & Miss. R.	Miscell	2	1	0.3	364	315	37	12
Midwest Towing Co	GIW, Miss, Ten, Ill RW.	Coal, Grain, Steel	1	5	18.3	112	-	112	-
Mobil River Sawmill	GIW, Ala, Pasca Tomb, Warrior	Logs, Pulp Logs, Pulpw.	3	6	1.3	30	-	30	-
National Marine Service	GIW/Miss/Ohio R.	Liquid/Chem	2	18	26.5	95	-	-	95
Ohio Barge Line	GIW/Cumb/Kan/Ky/ L. Miss/Mon/Ohio	Steel, Bulk, Chem	1	11	42.6	38	-	-	38
Ohio River Co	Miss. River System	General Com	1	26	63.9	1163	-	1163	-
Oil Transport	GIW/Mississippi	Asphalt/Fuel Oil	2	8	20.1	32	3	-	29
OKC Dredging	GIW/Inland/Miss.	Sand, Gravel Shell, Cement	3	14	4.4	48	43	-	5
Parker Brothers	GIW/Matagorda San Antonio	Cement, Shell Construction	2	15	10.7	67	67	-	-

Exhibit 1
SELECTED TRANSPORTATION LINES
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Operator	Service Areas or Limits	Key Commodity	Service	Towboats	Total HP (000)	Total Barges	Deck	Hopper	Tank
Palton-Tully Tramp Co.	Miss River/ Tributaries	Stone, Log, River-Imp	1	17	11.1	67	67	-	-
Pillsbury Co.	Miss. River/ Chicago/Ill Area	Corn/Soybean	2	0	0	70	70	-	-
Pinebluff Sand & Gravel	Mo/Miss/White/ Ark/Red Rivers	Construc/EQP	3	18	7.9	79	76	3	-
Security Barge Line	GIW, Miss River System	Grain, Bulk, Steel	1	3	11.8	109	-	108	1
Shell Oil Corp.	GIW/Vermillion Bay	Steel, Drilling Chemicals	3	20	38.2	47	47	-	-
Sioux City & N.O. Barge	GIW of LA & Texas	Towing/Cargo	1	17	41.8	315	-	164	151
Southern Towing Co.	Miss. River System	Pet Prod	2	11	29.9	52	-	-	52
Standard Dredging Co.	New Orleans and Inland	Supplies, Eqp, Fuel	2	7	1.8	25	20	-	5
Tenn. Valley Authority	Tenn. River	Bulk, Constr. Mtl, Miscel.	3	17	5.0	85	77	1	7
Texaco Inc. (All Divisions)	GIW/Miss. River	Petr. Prod.	3	14	9.8	57	50	-	7
Theriot, Nolty J. Inc.	Misc.	Towing	2	23	125.4	-	-	-	-
Thomas, Marine Co.	GIW/Miss/ Tributaries	Petrl Liq. Chem.	2	7	24.2	41	3	-	38
Thomas Petroleum	GIW/Miss/ Tributaries	Petrl. Prd Liq. Chem	2	5	13.7	66	-	-	66
Twin City Barge & Towing Co.	Miss/Min/St. Croix Ill/Gt. Lakes	Constr./Gasoline Grain/Coal	2	26	26.9	38	23	12	3

Operator	Service Areas or Limits	Key Commodity	Service	Towboats	Total HP (000)	Total Barges	Deck	Hopper	Tank
Union Mechling Corporation	GIW/Ark/Miss R./	General, Grain	1	19	84.0	692	20	551	121
Union Oil	GIW/Miss/	Petr. Prod.	3	8	10.2	13	-	-	13
United Barge.	Miss. River	Charter	2	1	3.6	302	115	187	-
United States Steel Corp.	Mono/Ohio	Bulk	3	7	5.5	264	85	179	-
United States Steel (Am. Div.)	GIW/Miss.	Steel, Constr. Mil	3	2	0.8	24	24	-	-
Upper Missi. Towing	Miss.	Chem, Bulk, Cet	2	7	41.2	360	44	292	24
Valley Line Corporation	GIW/Miss.	Crude Oil	2	26	97.0	548	196	351	1
Walker Towing Corp.	Miss.	Bulk	2	7	18.0	11	10	-	1
Warrior/Gulf	GIW/Inland/ Miss/Warrior	Steel, Ore, Chemical	1	19	32.6	216	40	176	-
Waterfront Service	Ohio R./Cairo, Ill./Inland	Towing	2	9	5.5	38	16	21	1
Waxler Towing Co.	GIW/Miss.	Chem.	2	4	8.6	17	-	2	15
Weither's Towing Co.	Miss. River	Towing	2	9	27.5	1	-	-	1
Weirton Ice & Coal	Ohio	Towing, Coal	2	1	1.0	20	-	20	-
Williams-McWilliam	GIW/Miss.	Dropseed Oil, Eqp	2	24	6.7	49	37	-	12
Wisconsin Barge Line, Inc.	Miss/Ill/Ohio	General	2	16	74.9	417	-	417	-
Zito Barge Line, Inc.	Int. Coastal/ Miss. Canal	Bulk	2	4	3.8	37	-	37	-
82 LINES	TOTALS			807	1797.1	12362	1983	8668	1711

Source: U.S. Army Corps of Engineers Transportation Lines of the the United States, 1976, Series 4.

Exhibit 2

SUMMARY OF SELECTED TRANSPORTATION LINES
Mississippi River System and Gulf Intracoastal Waterway
1975

Sample Data

807 Towboats	62% of Domestic Transportation Fleet (Exhibit 4)
1,797,100 horsepower	79% of Domestic Transportation Fleet (Exhibit 4)
12,373 Barges	72% of Domestic Transportation Fleet (Exhibit 10)
1,983 Deck Barges	82% of Domestic Transportation Fleet (Exhibit 10)
8,678 Hopper Barges	73% of Domestic Transportation Fleet (Exhibit 10)
1,712 Tank Barges	62% of Domestic Transportation Fleet (Exhibit 10)

Lines

Service Type	No. of Lines	Average HP Per Line	Average No. of Barges Per Line
Class 1 - Regulated	11	38,800	356
Class 2 - Exempt	54	27,400	130
Class 3 - Private	17	9,600	85
Total	82		

Service Type by Barge Type

	Total	Deck	Hopper	Tank
Class 1 - Regulated	31.5%	3%	86%	11%
Class 2 - Exempt	56.9%	18%	68%	14%
Class 3 - Private	11.7%	42%	40%	19%

Barge Type by Service Type

	Deck	Hopper	Tank
Class 1 - Regulated	6%	39%	24%
Class 2 - Exempt	64%	55%	60%
Class 3 - Private	30%	6%	16%

B. Towboat Technology

There are 2,500 towboats with more than 3.5 million horsepower propelling more than 20,000 barges on the inland waterways system. Towboats have steadily become both more powerful, and smaller and lighter, developing horsepowers that have approached practical limits in the mid-1970s. This impending limitation in power poses a major challenge to continuation of improvement in fleet efficiency.

Towboats on the rivers and waterways may be divided into three distinct categories each of which has unique requirements.

- Workboats and fleeters--low horsepower vessels designed to handle and sort barges alongside terminals, to transport barges to and from bank or mid-stream anchor fleet areas and to break-off or add-on barges to line-haul tows moving in mid-stream. Crew accommodations are minimal and power ranges up to 1,500 hp. Approximately 1,100 craft with an aggregate 950,000 hp served inland waterways ports, terminals, and fleeting areas in 1975.

- Line-haul towboats--medium horsepower towboats with single or twin screws that handle the majority of multi-barge tows on all rivers in the inland waterways system. About 1,200 towboats of 1,950,000 hp operated on the Mississippi-Gulf Intracoastal systems in 1975. Line-haul boats frequently "turn-around" in

the Cairo area, transferring barges to and from higher horsepower towboats working the Lower Mississippi.

- Lower Mississippi and Ohio River line-haul towboats--high horsepower towboats with twin or triple screws move the largest tows in the relatively broad reaches of the inland waterway network.[1] Approximately 40 towboats aggregating more than 300,000 hp were in operation in 1975.

Exhibit 3 traces the towboat and tugboat fleet serving the Mississippi Network and Gulf Intracoastal Waterway. Exhibit 4 presents the 1975 towboat fleet serving interport inland navigation in the Mid-America area.

1. POWER AND PROPULSION

Efficiency in towboat operations has been largely realized through the construction of increasingly powerful line-haul and shift towboats within smaller, lighter and durable hull and deckhouse envelopes. The conversion of engine torque into propeller thrust has been the object of steady refinements that included the introduction of the German Kort nozzle concept to towboats in 1937, the use of high speed diesels, pneumatic clutches and reverse gearing rather than reversing engines in 1939 and flanking rudders in the years following World War II. 360° steering nozzles were first experimented with in the late 1940s and controllable pitch and Voith-Scheider propellers were tested in the 1950s, with only limited success.

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[1] *In 1977, year-end grain shipments attracted 10,500 horsepower towboats to points as far north as L/D 21 on the Upper Mississippi.*

Exhibit 3

TOWING VESSELS SERVING
THE MISSISSIPPI RIVER SYSTEM AND GULF INTRACOASTAL WATERWAY
Year End 1968-1975

Types of Vessels	1968	1969	1970	1971	1972	1973	1974	1975
Self-Propelled Towboats and Tugs								
Number of Vessels	2,214	2,297	2,344	2,427	2,293	2,333	2,404	2,541
Horsepower	2,133,649	2,274,599	2,305,305	2,548,578	2,654,112	2,848,674	3,226,545	3,574,850
Average Horsepower	964	990	983	1,050	1,157	1,221	1,342	1,406

Source: Army Corps of Engineers (courtesy of American Waterways Operators).

EXHIBIT 4

COMPOSITION OF THE MISSISSIPPI AND GULF
INTRACOASTAL WATERWAY[1]
INTERPORT TOWBOAT FLEET

1975

Towboat Class (HP)	Number of Towboats	Length	Average Breadth (feet)	Draft	Maximum Practical Tow Size[2]
300	150	46	15	4.2	2
600	250	57	18	5.1	4
1,200	500	78	23	6.9	8
1,800	103	110	29	8.6	12
2,500	52	131	33	9.5	14
3,300	88	146	34	8.8	17
4,300	49	146	37	9.5	23
5,000	36	150	40	9.4	26
5,700	32	160	45	9.4	28
7,000	22	175	50	9.0	33
8,400	11	180	52	9.2	36
9,000	2	182	58	8.6	38
10,100	4	190	54	9.0	40
2,278,700	1,299				

[1]Towboats engaged in inter-port transportation.

[2]195 x 35-foot barges.

Source: CACI, Inland Navigation Simulation Model (INSA), Army Corps of Engineers.

The severe limitations of navigable depth have forced naval architects to optimize wherever possible. Using tunnelled sterns, 10-foot diameter ducted (nozzle) propellers are now commonly operating in 9- and 10-foot channel depths. Propellers, nozzles, stern ducts, airfoil section flanking and main rudders and towboat bow, bilge and stern fairing have all been refined. Perfect trim of the towboat to maintain propeller immersion is achieved through fully compensating ballast tanks which counter fuel and lube oil consumption. Despite these improvements, the basic physics of propeller theory limit the horsepower a 10-foot diameter disc can absorb without excessive vibration, blade cavitation and thrust loss to approximately 4,000 hp. This restriction was appreciated in the early 1960s by inland waterways designers who assessed the likelihood of towboats exceeding 10 to 12,000 hp as small. The narrow reaches of all rivers except the Lower Mississippi causes the outboard propeller of triple screw towboats to draw on poor inflows of water and thus suffer from vibration and cavitation. These propellers are also subjected to increased damage by flotsam, bottom debris and grounding. Thus, twin screw towboats exceeding 7,000 to 8,000 hp will continue to be few in number reflecting operational limitations, while triple screw towboats will not exceed 10,000 to 12,000 hp.

On the broader and deeper lower Mississippi, the limit of 10,000 to 12,000 hp was reached for a number of reasons. Firstly, the rapid flowing lower Mississippi, unlike other rivers, can accommodate triple

propeller arrangements and 40-barge tows. This practical capability was determined principally for operational reasons including:

- Barge tow size on the Lower Mississippi is limited by river geography and not the need for horsepower in excess of 7,000 to 8,000. Negotiating river bends and maneuvering in mid-stream restrict tow to approximately 40 barges.

- Stone fill and pile dike improvements undertaken by the Army Corps of Engineers to maintain or increase mid-channel depth increased mid-channel current velocities and eroded towboat performance, particularly when moving up river.

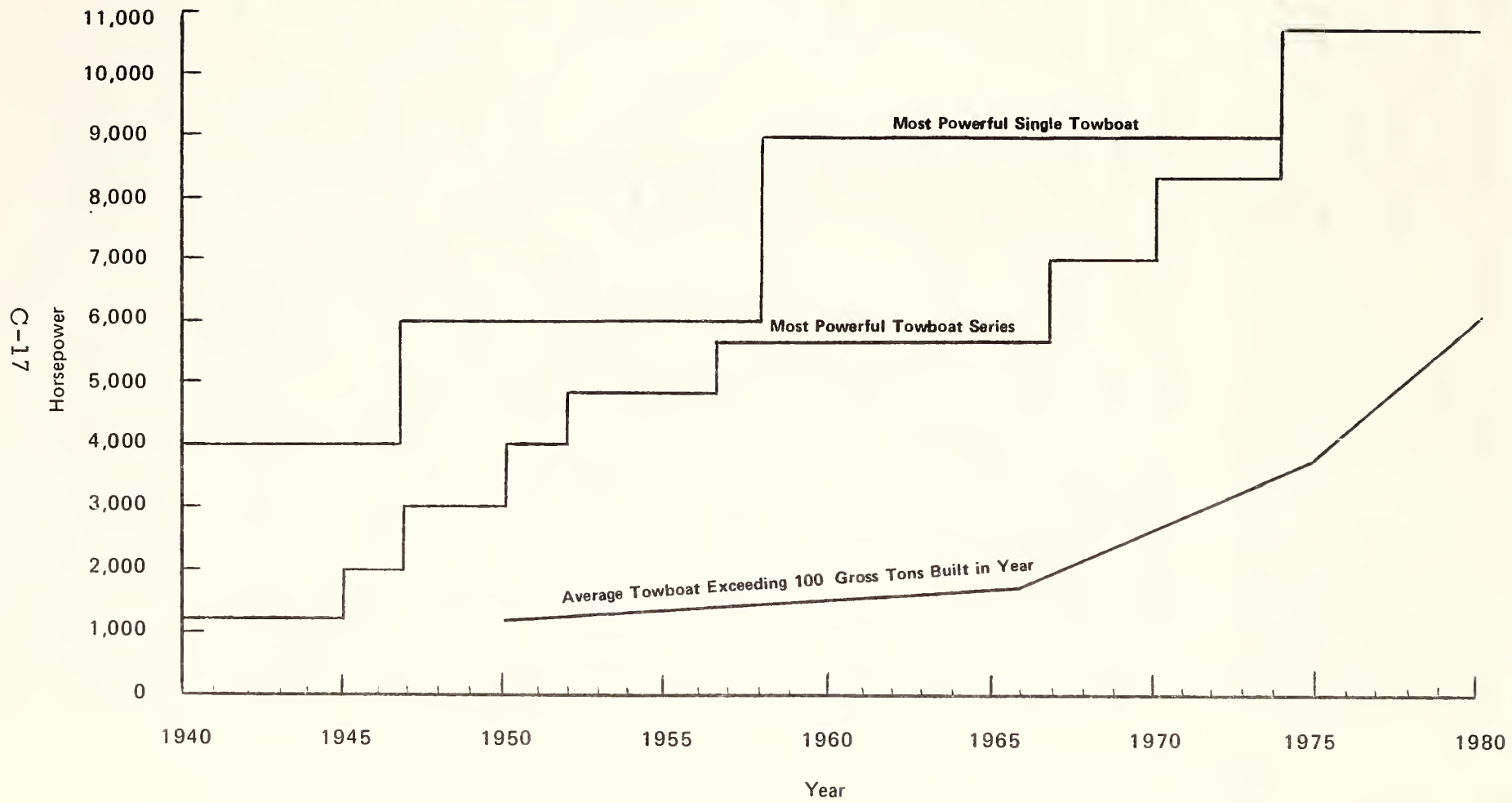
- This decrease in towboat performance forced towboats to navigate in the slower currents outside the channel during high water periods. 8,000 hp towboats are able to navigate this outside water with 40-barge tows. Recent construction by the Army Corps has utilized angled dikes from riverbanks, which even during high water periods do not permit tows to navigate in the outside water.

- Towboats have thus been forced back into the mid-channel where the current velocities have necessitated increased powers of 10,000 to 11,000 hp for intermittent use in restricted waters.

The recent demand for towboats in excess of 10,000 hp has been sufficient to justify the preparation of standardized 10,000 hp plus designs by several shipyards. Exhibit 5 shows this unprecedented development graphically, in which a standardized design now

Exhibit 5

COMPARISON OF MOST POWERFUL TOWBOAT AND MOST POWERFUL SERIES PRODUCTION TOWBOATS 1940-1980



represents the acme of towboat horsepower. The dominance of the river by two 9,000 hp towboats for 16 years, from 1958 to 1974, was indicative of the sufficiency of 6,000 to 8,000 hp vessels for even the largest inland waterways tows, until waterway improvements necessitated additional power for no corresponding increase in tow size.

Towboats have become smaller, lighter, and less costly to construct as diesel engines became more compact and powerful. Exhibit 6 graphically presents the more than 40 percent annual increase in towboat horsepower per gross ton delivered that had been achieved since 1950.[1] This increase was the result of successive refinements and improvements of diesel engine and marine engineering components that included adding cylinders to World War II engine designs, achieving savings in volume through V-arrangements of cylinders, improving crankcase materials to withstand increased dynamic and thermal stress and thus increasing the revolutions of American-built medium speed engines. Later improvements included the use of scavenged (forced) air supply and in the 1960s exhaust gas-powered turbocharges that afforded towboat owners an extended range of horsepowers on common basic engines. In the 1940s, clutch and geartrain developments eliminated the need for low speed direct reversing powerplants or heavy and relatively inefficient diesel electric installations which were 40 percent heavier than direct diesel plants. The weight of diesel engines per delivered horsepower is representative of post-war improvements: in 1942 a General Motors

[1]Gross tonnage is a cubic measurement of the gross volume enclosed by a vessel, including hull, superstructure, and deckhouses. 100 cubic feet equals 1 gross ton.

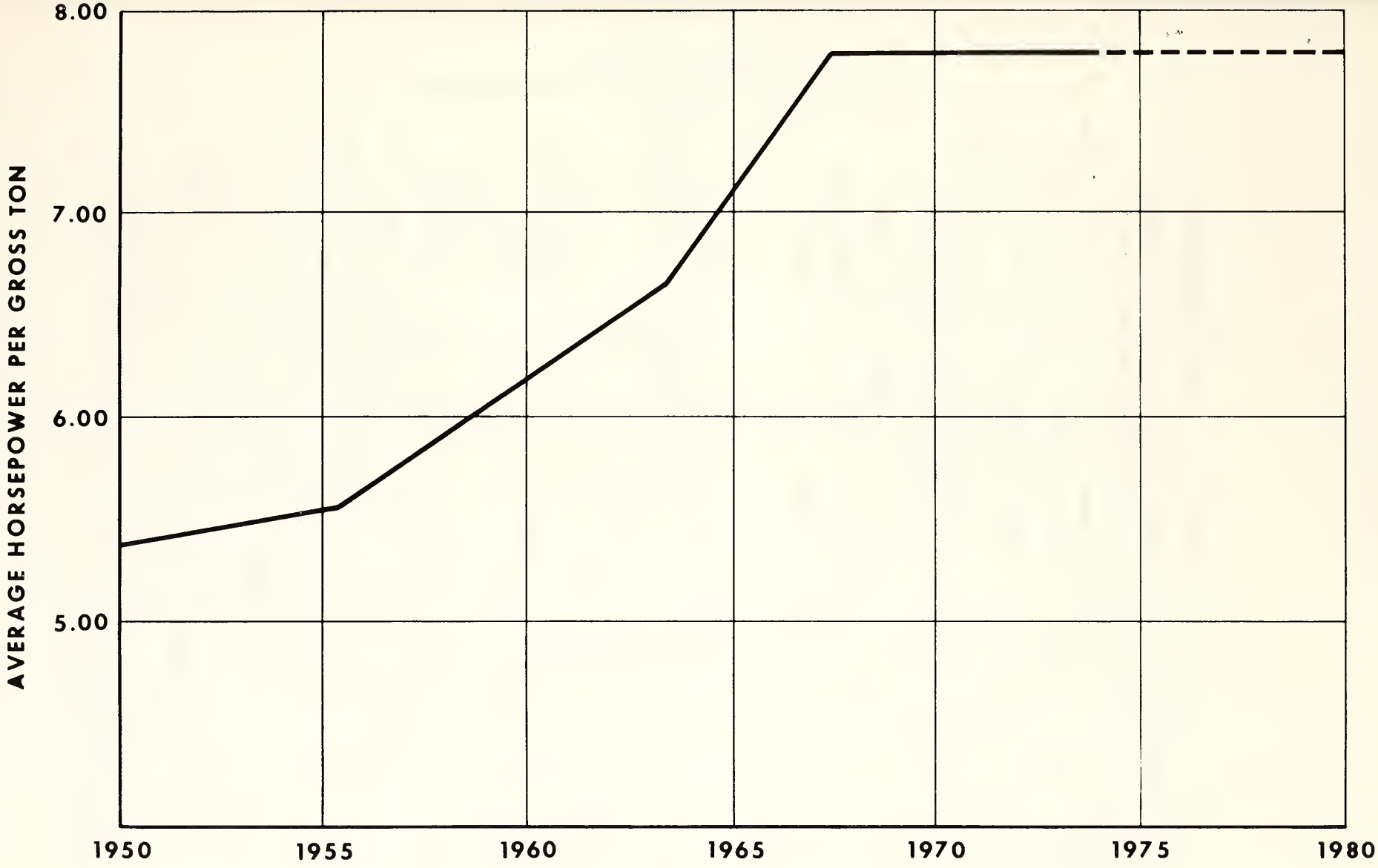


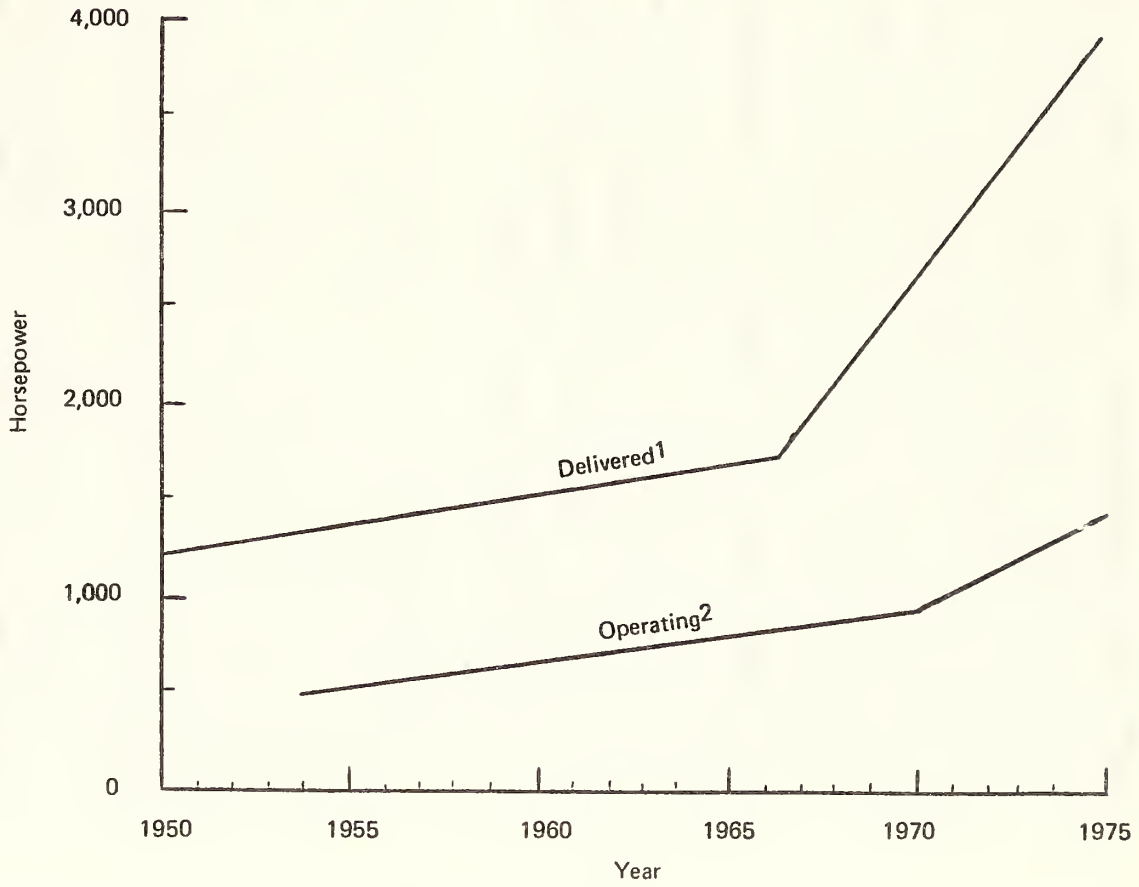
EXHIBIT 6 **TOWBOATS DELIVERED**
AVERAGE HORSEPOWER INSTALLED PER GROSS TON

basic 567 V-engine weighed 29 lbs. per horsepower, its turbocharged successor weighed 16.5 lbs. per horsepower, while the current turbocharged diesels weigh about 12.5 lbs. per horsepower. These savings in engine weight, as well as in gearbox weight, now permit towboats to accommodate 3-engine plants of 10,500 hp in the space required by a 3-engine 3,000 hp plant 30 years ago. Exhibit 7 depicts average towboat horsepower delivered and operating 1950-1980. The distinct increases in average horsepower delivered (1966) and operating (1971) are the result of turbocharging and a decrease in the construction of work and fleeting boats, respectively.

Despite these past achievements, the ability of the fleet to continue to increase propulsive performance at historical rates is doubtful (see Exhibit 6). The importance of cost effective propulsion has been increased by the post-1973 increase in fuel and particularly light diesel oil costs and towboat operators now seek the economy of lower cost higher fiscosity residual fuels. Consumption of heavier fuels requires higher cost engines capable of more than recovering this investment through the use of lower cost fuel. In 1945, .400 lbs. of fuel per horsepower-hour was consumed, twenty years later consumption of .375 lbs. was achieved and in 1977 diesels can burn residual fuels at the rate of only .33 lbs./hp hours. The introduction of slow and medium speed diesels to large American line-haul towboats is expected to take place in the early 1980s. In 1978, the U.S. Merchant Marine will receive its first slow-speed diesel-powered tugs for Gulf Coast integrated tug-barge operations.

Exhibit 7

AVERAGE TOWBOAT HORSEPOWER IN OPERATION AND DELIVERED 1950-1975



Note: Delivered--Towboats greater than 100 gross tons delivered in year.

Source: [1]Marine Engineering Log, Annual Reviews.
[2]American Waterways Operators (Army Corps of Engineers).

Increased horsepower will not be used indiscriminantly and like increased tow size does not guarantee an increase in the efficiency of river operations. Towboats and tows must be designed to meet operational requirements. High volume tows of a single commodity over long distances can be moved in integrated raked (bowform) and box (mid-body) barges at low speeds and uniform draft. This type of tow can be arranged into a long, wide flotilla and is capable of absorbing high horsepower with little damage. By contrast a short light tow will be damaged by the jostling of barges preceding an overpowered towboat. In general, operators engaged in long distance contract tows of grain, oils, coal, and selected commodity unit-tows and those performing the "for hire" long-distance movement of assorted tows of barges of different shapes, drafts and sizes will purchase towboats in the highest horsepower ranges.

The requirements of waterway terminals operations will dictate work and fleeting boat design. The dispersed location of many river facilities, storage areas and fleeting areas, combined with strong river currents and high volumes of barge traffic will require shift and fleet boats to have higher horsepowers so that barge handling delays and damage can be minimized.

The use of bow boats to assist in the steering and maneuvering of large tows is several decades old, but only since 1964 have small radio-remote controlled bow boats incorporating a diesel plant and 360^{o} ducted steering propellers come into use. Bow boats augment towboat thrust and swining power at the direction of the towboat pilot and offer:

- Better tow control entering locks, bridge underpasses, tight river bends, windy river reaches, river intersections and fleeting reaches.
- Better stopping power and collision avoidance.
- Additional line-haul thrust.
- Use as a standy fleeting vessel or shuttle unit at terminals.

As more 30 and 40 barge tows of uniformly loaded barges are assembled to move grains, petroleum and coal, the opportunities to position heavier barges closer to the towboat and lighter shallow-draft empties forward and outboard will decline, thus taxing the ability of towboats to steer the tows and increasing the likelihood of groundings, wind-bound tows and collision. The use of bow boats will continue to increase on long distance contract tows due to their many attributes.

2. DESIGN AND OPERATION

The towboat has and will continue to change only gradually in its arrangement, construction, and operation. Operators have reduced crew size and increased the dependability of higher horsepower vessels. Hull stiffness has been increased to reduce the effects of vibration with little penalty in weight. Peak tanks, void (empty) tanks and ballast tankage along towboat bilges have been adopted as a low cost means to protect fuel oil tanks from holing and leakage and to eliminate nearly all the previous gas-freeing of fuel tanks prior to hull repair. Recently constructed

towboats have also incorporated inner bottoms approximately 3-feet above the keel baseline to eliminate the risk of towboat sinkings due to holing in way of the engine room.

Above the waterline, towboat design reflects greater concern for comfort and convenience, qualities necessary to attract and keep top quality crew members. The use of hydraulic "up and down" pilot houses was incorporated into towboats operating on the Illinois River to Chicago with its 14 foot clearance limitation and towboats in the Minneapolis area as well. Eye level is typically 27 feet above water in the extended position so that pilots can see over their barges when not passing under low bridges. Accommodations have been standardized at a high level of comfort and detail to support continuous 6-hour on/6-hour off watches by a towboat's two crews on a nearly year-round basis. Higher crew morale and attention to the details of maintenance schedules, combined with improved navigational and machinery instrumentation has permitted line-haul towboats to reduce annual days lost to less than 2 percent as presented in Table 1.

Table 1

ANNUAL OPERATING PROFILE OF 3,000 HP TOWBOAT[1]

Tons Moved:	289 million ton-miles
Days out of Service:	6
Days in Port Fleeting:	72
Days Running Empty, Downriver:	96
Days Running Loaded, Upriver:	190

[1]Source: "C.P. Propellers for River Towboats", Donald E. Ridley. Great Lakes and Great Rivers Section of the Society of Naval Architects and Marine Enginers, April 15, 1965.

Towboats now change crews and paperwork, take on fuel, water, lubricants provisions, toiletries and repairmen while underway, supported by "mid-streamer" craft operated by various enterprises who also offer crew parking and waiting areas ashore. Navigational aids have expanded from simple watermarks and river charts, augmented 50 years ago by wireless and later by radio telephone, to an assortment of sophisticated instrumentation including:

- Autopilots designed for use in river navigation,
- VHF radios with up to 55 channels,
- teletype and telex printed information transfer,
- single sideband radios,
- depth finders,
- turnometers or "swing indicators",
- radar-offering high resolution clutter free readings,
- true motion radar,
- intercoms and loudhailers,
- rudder angle indicators, and
- powerful searchlights and floodlights to aid in night navigation and operations.

Towboat machinery installations are now monitored by sensory systems that display and record operating conditions at up to 50 poitns in main and auxilliary machinery systems. Detailed alarm information is available to chief engineers in sound-proof central

control rooms on towboat main decks while basic alarm systems notify the pilothouse of any system failure. Machinery failures can be simultaneously telexed to shoreside maintenance and repair services. Recently, shipbuilders have installed closed circuit television scanners at key locations in towboat machinery spaces to reduce the need for engineers to leave the control room. The control of auxiliary power plant, electrical, ballast, fuel, bilge, fire, and ships service components from consoles within the control room is another recent improvement in convenience and safety aboard line-haul towboats.

These advances in instrumentation have contributed to a reduction in the size of a towboat's engineering staff, but have not decreased the workload. Rather, personnel are capable of conducting maintenance operations and repairing machinery while the towboat is underway. This includes the replacement of pistons, cylinder linings and valve assemblies, turbocharger shafts and fuel injectors, repairs which previously required vessel down-time.

The deck department of towboats has not been so easily trimmed as its engine room counterpart. The size of tows and individual barges, moving at high speeds still requires human judgment and attention to the composition of each tow. Despite the use of improved ratchets and hydraulic and air-powered winches aboard towboats to tighten security wires and backing lines, the assembly of a large tow is an arduous and time-consuming task, particularly when barges are in varying

sizes, beams, drafts, arrangements, and states of repair. Three or four men are required to run out rope safety line wires and set up wires using heavy steamboat ratchets that tighten barges into a manageable tow. While some towboat captains will "grab hold" of barges with synthetic line and get underway, others prefer to lay-over on a riverbank and put the tow in "iron" (lashed and tightened with wire and ratchet turnbuckles) before getting underway. Either preference has a cost, the former is lost, damaged or runaway barges, the latter in the costly delay of a tow. Aluminum and other lightweight ratchet designs have yet to be fully accepted by the industry and their impact on the lash-up time is not significant. Several patented ratchets mounted on pedestals and anti-rotational hook assemblies are reported to be as much as four times as fast as winches.

The 16-man crew serving on the most powerful Mississippi and Ohio towboats represents a practical minimum. Fewer crewmen could be assigned only with a loss in the response to foul weather, or a sinking or runaway barge.

Exhibit 8 summarizes towboat complements at present and historically. A substantial reduction in crew size for today's towboats has been achieved, predominantly in engine department officers. The number of deckhands assigned to large towboats remains unchanged, and a watchman is a common member of a towboat's complement. Overall, a five fold

Exhibit 8

TOWBOAT COMPLEMENTS

1947 and 1975

3,000 HP Towboat 1947 Design	10,500 HP Towboat 1975 Design	5,600 HP Towboat 1975 Design
	Complement	
1 Captain	1 Captain	1 Captain
2 Pilots	1 Pilot	1 Pilot
1 Chief Engineer	1 Chief Engineer	1 Chief Engineer
1 First Mate	1 First Mate	1 First Mate
2 Asst. Engineers	1 Asst. Engineer	1 Asst. Engineer
2 Second Mates		
1 Third Engineer		
6 Deckhands	6 Deckhands	4 Deckhands
4 Striker Engineers	2 Striker Engineers	1 Watchman
1 Tankerman	1 Watchman	1 Cook
1 Cook	1 Cook	
2 Maids	1 Maid	
25 Total	16 Total	11 Total
	Summary	
11 Officers	5 Officers	5 Officers
14 Crew	11 Crew	6 Crew
14 Deck Dept.	10 Deck Dept.	8 Deck Dept.
8 Engineering Dept.	4 Engineering Dept.	2 Engineering Dept.
3 Stewards Dept.	2 Stewards Dept.	1 Stewards Dept.

reduction in high horsepower towboat manpower per horsepower has been realized in the past three decades. Given the general union requirement for 1 day off for each day worked, this fact is a critical means of cost reduction.

C. Barge Technology

More than 20,000 barges serving the Mississippi River system and the Gulf Intracoastal Waterway carry the full range of inland waterborne movements. The barge, in conjunction with the propulsive power of a towboat, becomes a highly material (capital cost), and energy and manpower efficient transportation mode relative to its overland competing modes. Although barge access to cargo is limited to riverside terminals, the level of service it offers shippers is highly competitive and sufficient reason for continued plant location decisions to call for siting along the inland waterways.

The barge types and technology that has evolved to serve the demand for wateway navigation reflects the composition of the cargos. In 1975 more than 75 percent of all short-ton internal and local traffic in the Mid-American area consisted of only 9 of the 175 SSCC commodities. Exhibit 9 presents these 9 commodities and the barge types most frequently used to transport these commodities. Exhibit 10 summarizes the more than 17,000 barges deployed on the Mississippi and Gulf Intracoastal Waterway in 1975 that engaged in transportation services. This fleet has absorbed more than 80 percent of the nation's annual barge construction on a capacity basis, and more than 85 percent on a

EXHIBIT 9

LEADING COMMODITIES AND BARGE TYPES

Commodity Code	Commodity Name	Percent of Total Tons[1]	Barge Type(s)
1121	Coal and lignite	35.1	Open Hopper
1442	Sand, gravel, crushed rock	9.1	Open Hopper
1311	Crude petroleum	6.6	Tank
2911	Gasoline	6.3	Tank
0103	Corn	6.1	Covered Hopper
2915	Residual fuel oil	4.2	Tank
2914	Distillate fuel oil	3.1	Tank
2819	Basic chemicals and products, NEC	2.9	Tank
4118	Waterways Improvement Materials	2.6	Open Hopper/Deck
Total		76.0%	

[1]Percent of 1975 short ton internal and local traffic on the main channels and tributaries of the Mississippi, Illinois, Missouri, and Ohio Rivers.

Source: Army Corps of Engineers, Waterborne Commerce of the United States, Part 2, Calendar Year 1975.

EXHIBIT 10

MISSISSIPPI RIVER SYSTEM AND
GULF INTRACOASTAL WATERWAY BARGE FLEET[1]

1975

Barge Type	Description	Number of Barges	Length & Breadth	Capacity Net Tons
Hopper	Open	204	245x35	2,400
Hopper	Open Jumbo	4,576	195x35	1,700
Hopper	Open Standard	2,408	175x26	1,060
Hopper	Open Small	977	120x30	630
Hopper	Covered Jumbo	3,861	195x35	1,700
Deck	200'	290	200x50	2,050
Deck	Jumbo	430	195x35	1,500
Deck	150'	677	150x32	600
Deck	Small--100'	1,030	100x26	350
Tank	290'	551	290x53	3,740
Tank	240'	727	240x50	3,000
Tank	185'	310	185x54	2,530
Tank	Jumbo	753	195x35	1,700
Tank	Small	440	135x40	1,300
Subtotal[1]		17,234		26,884,830
Other Barges, not listed[2]		3,794		1,665,456
Total		21,028		28,550,286

[1]Source: Transportation Lines of the United States, Series 4 as presented in the CACI Inland Navigation Simulation Model (INSA), Army Corps of Engineers.

[2]Includes dredging, construction, contractor, laid up, and idle barges.

vessel basis. Total U.S. barge output and average size constructed annually is presented in Exhibit 11.

Since 1950, the average deadweight of all delivered barges has increased from 1,130 to 2,670 deadweight tons, and a very substantial share of this increase has been realized on the inland waterways. Exhibit 12 traces the numbers of tank and dry cargo non-self propelled vessels operating on the Mississippi River System and Gulf Intracoastal Waterway 1968-1975.

Barges of all types have increased in efficiency during recent decades, both at terminals through improved cargo handling and fleet management techniques and through improvements in shipping technology which have taken four distinct forms:

- Increased controlling depths.
- Improved barge hydrodynamics.
- Improved barge construction.
- Specialized barge design.

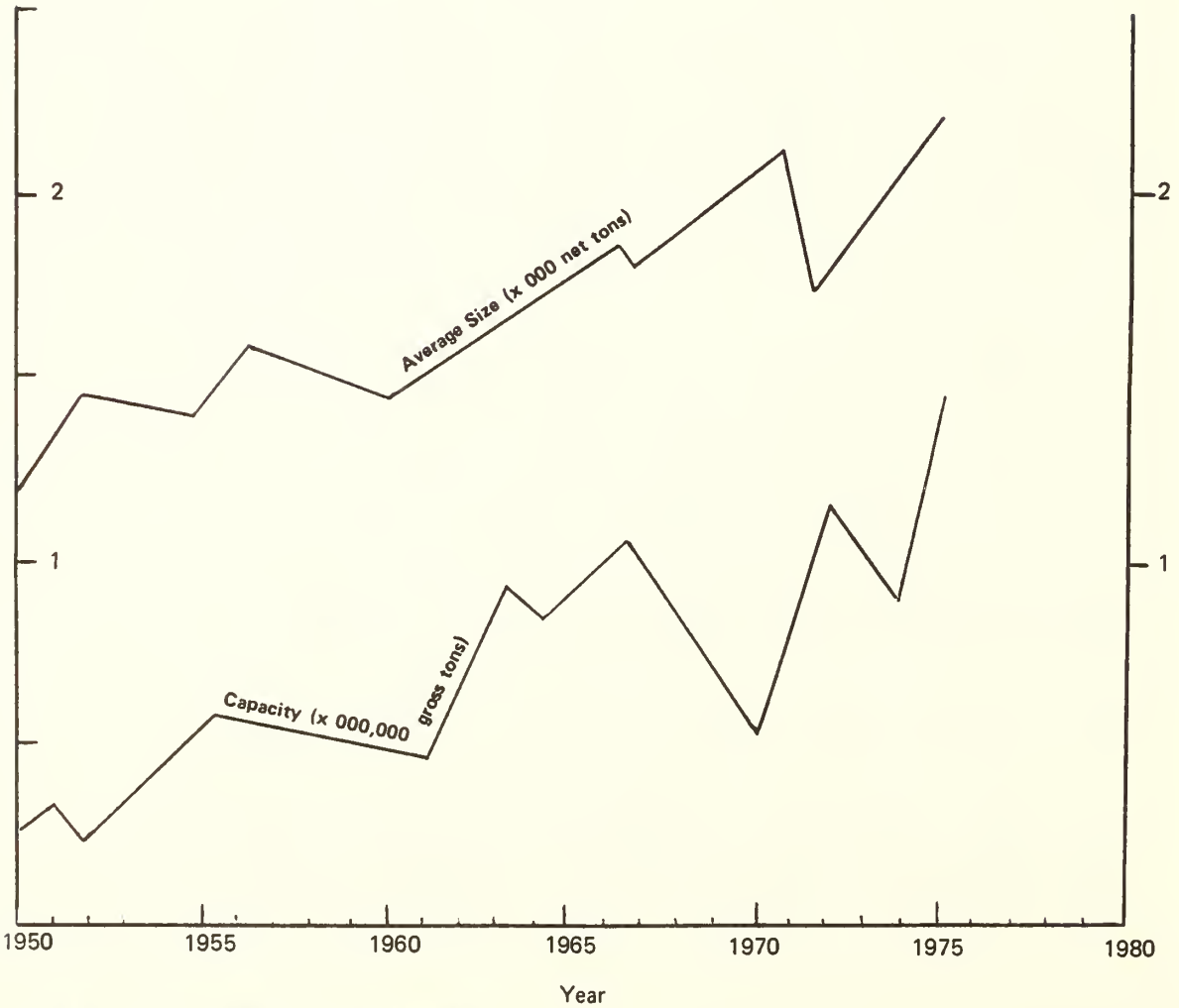
Each form of improvement is discussed below.

1. CONTROLLING DEPTHS

The increase in controlling depths throughout waterway mainstreams has permitted existing barges to be consistently loaded to deeper drafts and larger

Exhibit 11

U.S. BARGE CONSTRUCTION: AVERAGE SIZE AND TOTAL CAPACITY DELIVERED



Source: Marine Engineering/Log Annual Reviews.

EXHIBIT 12

MISSISSIPPI RIVER SYSTEM AND GULF INTRACOASTAL WATERWAY BARGE FLEET
Year End 1968-1975

	1968	1969	1970	1971	1972	1973	1974	1975
Dry Cargo Barges and Scows								
Number of Vessels	12,056	12,550	13,318	13,985	14,904	15,765	17,345	18,049
Cargo Capacity (net tons)	13,508,798	14,284,009	14,863,812	15,934,718	17,293,167	18,583,511	21,031,652	22,255,050
Average Capacity	1,120	1,138	1,116	1,139	1,160	1,178	1,212	1,233
Tank Barges								
Number of Vessels	2,480	2,657	2,581	2,788	2,697	2,751	2,903	2,979
Cargo Capacity (net tons)	5,678,991	4,821,062	4,753,480	5,591,111	5,841,980	5,653,353	6,117,768	6,295,236
Average Capacity	2,290	1,814	1,842	2,005	2,166	2,055	2,107	2,113
Total Nonself Propelled								
Number of Vessels	14,536	15,207	15,899	16,733	17,601	18,516	20,248	21,028
Cargo Capacity (net tons)	19,187,789	19,105,071	19,617,292	21,525,829	22,775,147	24,236,864	27,149,420	28,550,286
Average Capacity	1,320	1,256	1,233	1,286	1,293	1,308	1,340	1,358

Source: Army Corps of Engineers.

barges to be designed. The draft of barges is today determined increasingly by controlled channel depths. This increased draft and barge depth has permitted larger, longer barges to be developed. Third generation 250 x 52-1/2 foot barges permit reduction of loading, shifting, fleeting and make-up times that range up to 50 percent, and can carry an additional 350 tons of cargo with each foot of increased controlling channel depth.

2. BARGE HYDRODYNAMICS

Barge hydrodynamics have been an area of interest to designers since the early 1930s. Today barges incorporate raked bows, bilge radii and sterns designed to reduce drag and increase directional stability. The increased operation of unit tows of bulk commodities has fostered the use of integrated barge tows consisting of leading bow-rake barges and following box barges loaded to a uniform draft. Developed in the 1940s for liquid bulk transportation up the Missisippi, integrated tows for dry bulk commodities were in use in the early 1950s. The construction of standardized barges with eight-foot nine-inch drafts and 26, 35 and 50-foot beams is a less dramatic but equally important hydrodynamic improvement that serves to minimize towboat power requirements and transportation costs.

3. BARGE CONSTRUCTION

Improved barge construction through improved materials, coatings, and fabrication technologies have reduced barge maintenance requirements. Better

structural design has reduced barge light ship (tare) weights, thus increasing displacement available for barge cargo. Fibreglass hatchcovers on grain-hopper barges is an example of weight savings in barge outfitting.[1] Barges are constructed today of wire-brushed and shot-blasted, primed, continuously welded steel. Rust and crack-prone welds are inspected and all weakening slag removed. Efficient use of steel through longitudinal framing, continuous welds and simplified shipyard plate handling and cutting has resulted in barges requiring only 375 lbs. of structure per ton of capacity, as compared to railroad cars which average some 550 lbs. per ton of capacity.

Barge maintenance and inspection has been reduced through the use of improved coatings to preserve barge structures, rotary lock manholes for speedy inspection and access to barge interiors, and the use of inner bottoms. Proprietary rigid polyurethane foams are extending barge life, lowering maintenance costs, freeing towboats crews, fleeting services and salvage teams from the routine pumping of sinking barges.

4. DESIGN SPECIALIZATION

The current direction of barge design is towards comprehensive system compatability between terminal technology and barge design. In recent years barges dedicated to the major commodity groups (coal, petroleums and chemicals, aggregates, and agricultural products) have appeared.

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[1] *Aluminum hatch covers, common aboard many covered hopper barges, are to be banned by the U.S. Coast Guard in 1978 as hazardous in fires.*

Liquid bulk cargos are served by a variety of tank barge designs in sufficient supply during the mid-1970s. Crude petroleum cargos are handled by double-skinned barges fitted with coils fed by self-contained or shore-based steam plants and can discharge cargos in 8 hours or less. Improved coatings protect products barges, while compartmentalized designs serve parcel oil and chemical transportation. Cylindrical tank barges capable of transporting liquids under pressure are increasingly common.

Covered hopper barges are available for the carriage of weather sensitive commodities notably grains, ores and fertilizers. Traditional grain discharge by pneumatic elevators and mechanical marine legs have been relatively low-capacity, high energy consuming operations (300 tons per hour unloading). This led terminal operators to emphasize efficient fleeting, shifting and hatch cover operations to reduce down-time. Larger barges, rolling and lightweight lifting hatch covers were some results. The use of fixed captive barges for positive breasting--along which a string of barges may be moved into position by a shoreside barge puller--is another. Parascrew and continuous barge unloader technology is at hand with discharge capacities of 3,000 tons per hour and will speed covered hopper barge unloading in the future. Larger covered barges will be required to reduce shifting time.

5. THE BARGE/CARGO HANDLING INTERFACE AND THE FUTURE

The large grain shipments originating along the Upper Mississippi Region require highly efficient barging due to the shorter navigation season and the tendency of the Upper Mississippi to suffer from low water levels that requires slowed towing and reduced barge loads. A shortage of covered hopper barges on the Upper Mississippi remains a seasonal problem.

The development of western coal and the competition for its transportation by rail and barge interests has recently spurred terminal technologies emphasizing broad tandem-bucket continuous barge unloading (CBU) that cut through large portions of a hopper cross-section in a single pass. Using catenary suspension endless belts to achieve low-speed motions adjacent to barge hopper sides and bottoms, coal hopper barges may now be designed to withstand years of service without the use of heavy timber bottom boards. These bottom boards, which robbed barges of useful volume and dead-weight as they became water-logged, were previously necessary to protect barge bottoms from grab-bucket operations.

The development of integrated dry bulk barge types and competitive pressures in eastern and western Kentucky coal mines fostered integrated terminals and pooled coal loading facilities using shuttle barge power units and shoreside barge-pullers to speed re-positioning. These techniques permitted a single shiftboat to serve 4-6,000 ton per hour operations as

compared to the 600-2,000 ton per hour loadings common in the 1950s and 1960s. A 22,500-ton-tow composed of 15 (195 x 35 foot) second generation jumbo hopper barges can now be loaded in 5 to 7 hours at an integrated major mine facility with only three 5-barge cuts and only three changes of barge-hauling wires. To unload barges at comparable rates, CBU technology is mandatory.

A 22,500-ton tow consisting of eight (250 x 52 1/2-foot) third generation barges requires the same loading time as a 15 barge 195-foot tow, but realizes significant savings in continuous unloading operations because CBU elevators are horizontally fixed and barge pulling and changing is critical to its efficient operation. Exhibit 13 shows the increased efficiency realized in CBU operations in conjunction with third generation barges.

In addition to the improved tank, covered, and open hopper barges of the future, other special purpose barges will appear to meet shipping requirements. The fleet of inland barges is served by a barge-building industry currently capable of producing more than 1,500 hopper barges and approximately 25 million tons of capacity annually. This production potential and the longevity of the existing fleet, permits the inland wateways to absorb major and rapid changes in specific commodity flow changes. This fact is underscored by the fact that in 1975 some 6,800 hopper barges were operating on the Mississippi and Gulf Intracoastal Waterways, while in January 1977 the 36 largest barge companies operated 10,000 hopper barges, more than 3,000 in coal service alone.

EXHIBIT 13

CONTINUOUS BARGE UNLOADING TIMES

A Comparison of the Time Required to Unload
22,500 Tons in Various Sized Hopper Barges
With a 5,000 Ton Per Hour Installation

	1st Generation Hopper Barges	2nd Generation Hopper Barges	3rd Generation Hopper Barges
Number Barges in Tow	23	15	8
Capacity each, tons	1,000	1,500	2,800 dwt
Length Width	175 x 26'	195' x 35'	250' x 52 1/2'
Description	Open Hopper	Jumbo Barge Open Hopper Barge	3rd Generation Open Hopper Barge
CBU Rated Capacity, tph	5,000 tph	5,000 tph	5,000 tph
Clear Digging Time, minutes	12	18	33
Backhauling and Positioning, minutes	2	3	4.5
Clean-up minutes	6	9	13.5
Barge Changing, minutes	13	15	19
Total time per barge	33 minutes	45 minutes	70 minutes
Total Tow Throughput Time	12 hours, 40 minutes	11 hours, 15 minutes	9 hours, 20 minutes
Time Over 3rd Generation Barges	3 hours, 20 minutes	1 hour, 50 minutes	
Time Penalty, percent	(36%)	(20%)	Future Standard

Source: TBS estimates, based upon trade information.

D. Unconventional Inland Waterway Technology

1. BARGE CARRYING VESSELS

The barge carrying ship concept (Lighter Aboard Ship) in international trade is less than one decade old and remains almost exclusively a United States Gulf Coast mode of transport. The potential to carry a broad range of cargos in barges complements the diversity of cargos exported and imported by businesses in the Mississippi River Basin and along the Gulf Intracoastal Waterway.

The barge carrying concept emphasizes the rapid, secure, and relatively flexible transport of low, medium, and high value import and export cargos. Its primary market is shippers and consignees located within navigable river hinterlands with ready access to waterside terminals engaged in regular movements of less-than-shipload and multi-container lead lots. The volume of cargos frequently makes the barges voyage from river terminal to harbor, harbor to overseas foreign harbor and then, to river terminal a productive form of warehousing and inventory. Access to waterside terminals is a key element to shipper behavior for the use of several container lots on a regular basis is a more universal and conventional solution to less than shipload import/export logistical problems. Cargo markets that have been successfully penetrated by

barge carriers and are consistent with the intended market include grains, rice, paper, pulp, lumber, textiles, non-ferrous ores, scrap and electric machinery.

The barge carrier concept has been realized in two forms, both consisting of a high-speed self-sustaining mother ship and an inventory of standard barges. The prototype and more prolific class, LASH (Lighter Aboard Ship), employs 370 deadweight ton barges sized to be adaptable to European inland waterways. However, LASH barges are not popular with American waterway operators because of their non-standard dimensions. Its successor SEABEE, utilizes larger barges of 850 tons deadweight, dimensioned for maximum compatability with the 195 x 35-foot standard jumbo barge used on America's inland waterways.[1] LASH and SEABEE barge carriers achieve effective loading/discharge rates of 3 and 2 barges per hour, respectively, reducing port calls to two days or less. Exhibit 14 details the characteristics of LASH and SEABEE barges.

The fleet of barge carriers serving the U.S. Gulf Coast and the world was largely constructed in the early 1970s. Exhibit 15 presents the barge-carrying fleet serving the U.S. Gulf Coast in 1978. Only four such ships have been ordered worldwide since the oil embargo of 1973, two are for Russian registry. Four Pacific Far East Lines LASH vessels are presently being converted to full containerships.

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[1] *LASH carriers lift barges with a gantry crane, while SEABEE carriers utilize a platform elevator and deck rollers to transfer barges.*

EXHIBIT 14

CHARACTERISTICS OF LASH AND SEABEE BARGES

	LASH	SEABEE
Overall Dimensions:		
Length	61' 6"	97' 6"
Beam	31' 2"	35' 0"
Depth	12' 0"	12' 6"
Draft	8' 6"	
Internal Dimensions:		
Length	59' 9"	90' 0"
Width	29' 5"	30' 3"
Depth of Hold	10' 2"	14' 6"
Capacities:	19,900 ft.^{3} 370 long tons	39,140 ft.^{3} 830 long tons
Additional Characteristics		
Hatch Covers	44'x26' Liftoff	84' x 30'3"
Hull Construction	Steel	Steel
Lightweight	83 long ton	135 long tons
Total in U.S. Inventory 12/75	3,110[1]	246

[1]In 1977 802 Pacific Far East Line LASH barges were offered for sale worldwide for a variety of uses. This will reduce the U.S. inventory significantly.

Source: MarAd, Inventory of American Intermodal Equipment, 1976.

EXHIBIT 15

BARGE CARRIERS
SERVING U.S. PORTS IN 1978

Owner	Name	Flag	Dwt	Barge Capacity	Year Built	Principal Coast	Foreign Service Area
Central Gulf	Green Harbor	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Green Valley	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Green Island	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Lash Atlantico	U.S.	29.8	77	1974	Gulf	Persian Gulf
Prudential	Lash Italia	U.S.	30.2	77	1970	Atlantic	S. America
	Lash Pacifico	U.S.	30.2	77	1972	Atlantic	S. America
Delta Steamship	Delta Mar	U.S.	40.7	70	1973	Gulf	S. America
	Delta Norte	U.S.	40.7	70	1973	Gulf	S. America
	Delta Sud	U.S.	40.7	70	1973	Gulf	S. America
Farrell Lines	Austral Moon	U.S.	29.7	77	1973	Atlantic	Africa
	Austral Rainbow	U.S.	29.7	77	1972	Atlantic	Africa
	Austral Lightning	U.S.	29.7	77	1971	Atlantic	Africa
Waterman	Robert E. Lee	U.S.	40.9	89	1974	Gulf	Persian Gulf
	Sam Houston	U.S.	40.9	89	1974	Gulf	Persian Gulf
	Stonewall Jackson	U.S.	40.9	89	1974	Gult	Persian Gulf
COMBI	Munchen	For.	44.8	80	1972	Gulf	Europe
	Bilderdyk	For.	44.8	80	1972	Gulf	Europe
Lykes Lines[1]	Almeria Lykes	U.S.	38.4	38	1972	Gulf	Europe
	Doctor Lykes	U.S.	38.4	38	1972	Gulf	Europe
	Tillie Lykes	U.S.	38.4	38	1973	Gulf	Europe

[1]SEABEE barge carriers.

Source: MarAd, Inventory of American Intermodal Equipment, 1976.

Following the oil embargo massive port congestion in North Africa, Red Sea, and Persian Gulf ports created opportunities for unconventional rapid-turnaround self-sufficient vessels. Hundreds of specialized craft, including heavy lift and roll-on/roll-off vessels were constructed to meet these opportunities, but not a single barge carrier entered service despite the apparently favorable conditions. The absence of U.S. and foreign barge carrier orders throughout this boom signifies the longer term limitations of the barge carrier concept, certainly in the eyes of current and prospective owners and operators.

Despite the low levels of barge carrier construction activity, the U.S. Gulf Coast fleet is projected to expand from 400,000 dwt in 1975 to some 845,000 dwt in 2000, an annual growth of 3 percent. This rate of growth represents a new stage in the life cycle of the barge carrier and is not a continuation of the nearly 50 percent annual early life cycle growth rate experienced in the Gulf between 1969 and 1975. Exhibit 16 presents a forecast of U.S. Gulf Coast barge carriers by vessel size and deadweight.[1]

This modest 3 percent annual growth in barge carrier supply through 2000 will fall short of the expected annual growth in high potential commodities.[2]

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[1] U.S. Merchant Fleet Forecast of Vessels in U.S. Foreign Trade, Draft Final Report, Temple, Barker and Sloane, Inc. January 1978.

[2] Foreign trade on the Mississippi River grew at the rate of 10 percent annually between 1966 and 1975 (U.S. Army Corps of Engineers).

EXHIBIT 16

FORECAST OF ANNUAL BARGE CARRIER
CAPACITY SERVING U.S. GULF COAST

1975-2000

Average Vessel Deadweight	1975	1980	1985	1990	1995	2000
29,800	-	1	1	1	1	-
38,400	3	3	3	3	3	1
44,000	9	9	13	13	15	18
Total Annual Capacity in Millions of Deadweight	2.110	2.900	4.270	4.440	5.270	5.330

Source: U.S. Merchant Fleet Forecast of Vessels in U.S. Foreign Trade, Draft Final Report, Temple, Barker & Sloane, Inc. January 1978.

Although the commodities of high potential represent a small portion of all Mississippi River system cargos on a tonnage basis, their value is proportionately higher than the majority of commodities handled at most inland waterways ports. It is for this reason that many local waterway port interests are hopeful that LASH and SEABEE barges can corner a larger share of containerized high value cargos originating in and destined for their hinterlands.

Given the absence of barge carrier fleet expansion, and the conversion of several LASH vessels into full containerships, the commitment of marine decision-makers to the barge-carriers concept falls short of that required to assure anything more than a gradual decline in the role of the barge carrier in inland waterway international trade.

2. THE MINI FLEET

In the late 1960s a Greek-owned fleet of small general cargo vessels commenced a service from the Gulf Coast to South America, West Africa and the Canal Zone from waterway terminals as far inland as Nashville.[2] A large fleet of standardized mini-ships was constructed in Japan expressly for navigation on inland waterways. The fleet circumvents the transshipment costs and delays at downstream ports that cargos

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[1]Areas served include the East and West Coasts of South America and Mexico, West Africa, the Canal Zone and the West Coast of Central America

destined or received from foreign ports close to the U.S. Gulf would have incurred. Although this fleet engaged in less than .5 percent of Mississippi River foreign trade, its competitiveness as a foreign-flag alternative to the costs of highly efficient towboat/barge and transshipment operations of the waterways is an interesting alternative. Details of vessels in the mini-fleet appear in Exhibit 17.

EXHIBIT 17

THE MINI FLEET
TYPICAL VESSEL CHARACTERISTICS

Length Overall:	215 feet (65.5m)
Length Between Perpendiculars:	206 feet (62.8m)
Breadth, Extreme	50.3 feet (15.3m)
Breadth, Molded	50.1 feet (15.3m)
Draft, Maximum	16.2 feet (4.95m)
Depth	21.7 feet (6.6m)
Deadweight	3,217 tons
Gross Tonnage	1,572 tons
Grain Cubic	3,785 m^3
Bale Cubic	3,669 m^3
Twin Diesels	2,000 hp - 10.25 knots
Twin Steel Hatches	14.6m x 7.7m (47.9'x25')
Twin Holds	21.3 and 21.9m long (69.9' and 71.8')
Cranes	1 - 8 ton 2 - 15 ton

Source: Lloyds Register of Shipping, 1976.

E. SUMMARY AND CONCLUSIONS

Technology on the inland waterways has been shaped by the characteristics of the rivers and has undergone a steady gradual evolution. Despite the developments that have taken place in past decades, the limitations of locks, river bends, and shallow water still indicate the form of inland navigation to a large extent. Because it is unlikely that these limitations will be altered to any great extent during the remainder of this century, gradual evolution and not quantum leaps in technological development will continue. It is also not expected that these changes will affect modal split in any way presently quantifiable.

Several recent forecasts of inland waterway technology have pointed to radical alternatives rather than feasible responses to the challenges currently facing river operators. These suggested alternatives have included sophisticated navigation and gas-turbine propulsion systems as well as the increased utilization of inter-modal systems, including the barge-carrying concept. Each of these proposals is unlikely to be realized except on a limited basis. Indeed, it is unlikely that the adoption of any new technology will be successfully adopted unless it meets the following time-tested criteria of the rivers:

- It is of almost universal application to inland fleet operations. Prospects include labor and time-saving lash-up systems, engines capable of operating on lower cost heavy fuels, and improved visual and radar-related navigational aids.

- It is consistent with the requirements for commonality and interchangeability.

- It is cost-effective.

Exhibits 18 and 19 pictorially summarize past technological developments in towboat and barge technology respectively. All improvements noted are of broad application to the industry. For this reason the inland waterway fleet can be expected to develop in the following manner:

- Towboats will continue to be produced at a rate of between 90-110 vessels per year with a total horsepower of between 400 and 500,000. Approximately 40 of these towboats will be exclusively major river line-haul towboats exceeding 1,000 hp. Between 3 and 5 towboats exceeding 10,000 hp will be delivered annually. Scrappings, losses and foreign sales will increase slightly from 20,000 hp at present.

- Towboat crew size will undergo only a slight reduction during the remainder of the century. Certain efficiencies will result from more efficient lash-up devices and the use of larger barges.

- Before the year 2000, the medium speed diesel engines will be used aboard lower Mississippi line-haul towboats.

- Bow boats will become increasingly dependable and common on line-haul integrated tows.

- The barge fleet will continue to be composed of deck, hopper and tank barges. Hopper barges of integrated box and rake configurations will continue to be produced for dry bulk unit-tows but at levels below peak 1975-1977 output. The tank barge fleet will grow slowly, primarily as specialized parcel compartmented and cylindrical tank craft are delivered.

Exhibit 18

TOWBOAT TECHNOLOGY

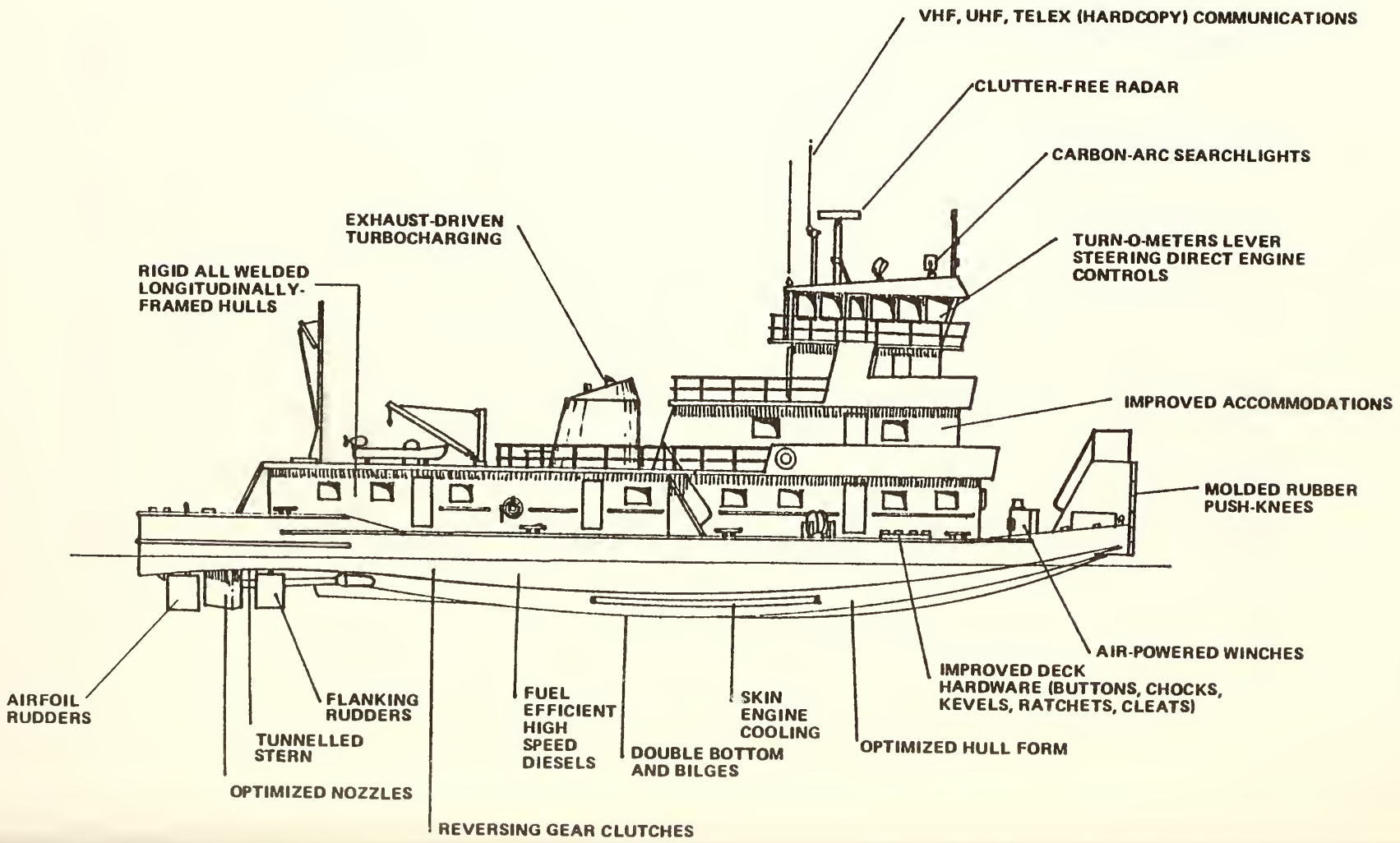
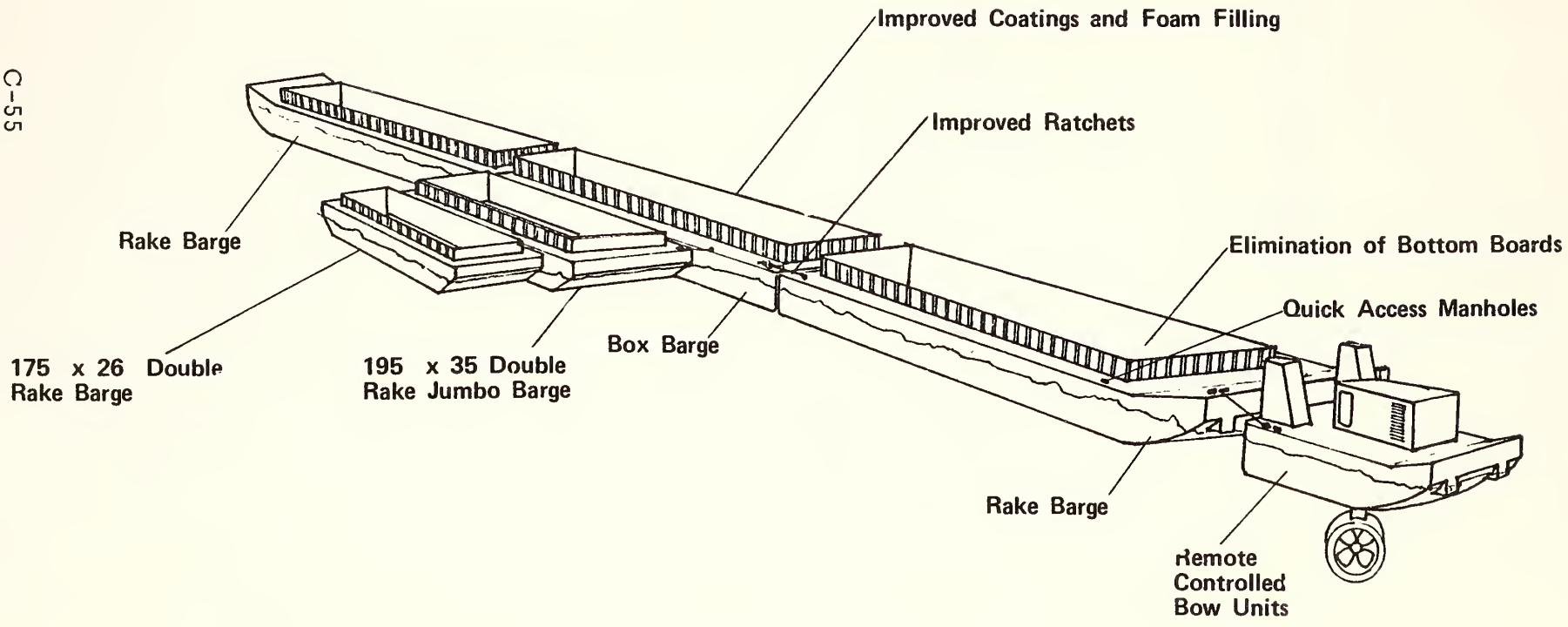


Exhibit 19

BARGE TECHNOLOGY



MID-AMERICA PORTS STUDY

APPENDIX D

ECONOMETRIC FORECASTS

APPENDIX D

ECONOMETRIC FORECASTS

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APPENDIX D

SECTION I

HISTORICAL AND FORECAST ECONOMETRIC VARIABLES BY STATE TO YEAR 2000

ALABAMA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	137.	174.	213.	256.	198.	124.	120.	157.	165.	156.	148.	133.
MFG SHIPMENT	8457.	8137.	8384.	9533.	10336.	10241.	9196.	10058.	12152.	15426.	19361.	30846.
FOODS	250.	291.	266.	302.	375.	358.	384.	422.	500.	622.	764.	1167.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	330.	347.	389.	453.	550.	570.	487.	550.	619.	724.	839.	1137.
APPAREL	225.	250.	264.	291.	336.	383.	353.	467.	516.	652.	805.	1256.
LUMBER	127.	140.	168.	248.	248.	187.	173.	235.	333.	485.	681.	1396.
FURNITURE	36.	41.	51.	58.	66.	65.	34.	41.	63.	87.	116.	216.
PAPER PROD	367.	364.	346.	401.	422.	516.	416.	486.	581.	767.	1001.	1723.
PRINTING	95.	117.	85.	90.	95.	104.	88.	93.	119.	161.	212.	377.
CHEMICALS	659.	558.	586.	433.	568.	562.	429.	545.	745.	1107.	1617.	3510.
PETROLEUM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RUBBER	227.	195.	276.	361.	410.	391.	348.	430.	581.	816.	1142.	2242.
LEATHER	-99.	-99.	-99.	9.	11.	10.	6.	7.	6.	6.	6.	6.
CLAY GLASS	109.	102.	117.	119.	124.	131.	109.	124.	132.	157.	185.	258.
PRIM METALS	625.	557.	530.	552.	669.	737.	567.	631.	829.	1100.	1416.	2418.
FAB METALS	206.	173.	189.	250.	271.	285.	266.	267.	327.	425.	543.	902.
NONELEC MACH	100.	88.	62.	109.	135.	175.	164.	180.	215.	271.	333.	516.
ELEC MACH	162.	210.	193.	264.	234.	242.	237.	255.	380.	609.	951.	2381.
TRANS EQUIP	243.	233.	252.	252.	305.	327.	270.	291.	416.	539.	693.	1153.
INSTRUMENTS	4.	5.	8.	20.	21.	22.	26.	27.	33.	43.	54.	88.
FERTILIZER	349.	356.	366.	397.	409.	414.	342.	390.	468.	556.	635.	759.
CASH GRAINS	1.	1.	1.	1.	1.	2.	2.	2.	2.	2.	2.	2.
COAL CONS	25582.	27198.	27694.	30064.	27695.	26719.	29798.	39455.	53287.	59881.	66436.	82830.
COAL PROD	17456.	20560.	17945.	20814.	19230.	19824.	22644.	21605.	26963.	38671.	54615.	110626.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

ARKANSAS

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	58.	82.	104.	121.	99.	60.	58.	72.	85.	108.	127.	190.
MFG SHIPMENT	4508.	4597.	4933.	5529.	6220.	5918.	5416.	6422.	8765.	11611.	15143.	26162.
FOODS	266.	266.	262.	298.	298.	329.	339.	381.	467.	590.	734.	1155.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	47.	58.	59.	63.	79.	68.	55.	67.	83.	104.	127.	195.
APPAREL	79.	90.	91.	100.	126.	126.	112.	150.	173.	215.	262.	399.
LUMBER	144.	137.	161.	196.	186.	218.	201.	235.	290.	373.	470.	761.
FURNITURE	79.	70.	87.	99.	115.	96.	69.	85.	109.	139.	171.	268.
PAPER PROD	165.	178.	195.	209.	203.	247.	191.	219.	266.	352.	461.	800.
PRINTING	77.	75.	76.	81.	89.	111.	78.	89.	114.	153.	201.	356.
CHEMICALS	104.	126.	141.	147.	148.	246.	282.	304.	355.	433.	525.	777.
PETROLEUM	31.	27.	24.	23.	29.	15.	75.	77.	79.	82.	84.	89.
RUBBER	103.	97.	116.	121.	137.	142.	125.	157.	256.	387.	578.	1304.
LEATHER	-99.	-99.	-99.	61.	60.	55.	54.	58.	51.	50.	50.	50.
CLAY GLASS	52.	56.	65.	71.	67.	70.	63.	73.	89.	125.	170.	325.
PRIM METALS	71.	80.	69.	76.	91.	90.	58.	66.	81.	100.	121.	182.
FAB METALS	73.	81.	95.	127.	169.	150.	138.	175.	253.	323.	407.	652.
NONELEC MACH	64.	59.	87.	105.	124.	144.	108.	128.	189.	235.	285.	431.
ELEC MACH	234.	261.	290.	366.	410.	400.	312.	345.	554.	918.	1476.	3930.
TRANS EQUIP	36.	48.	73.	87.	112.	104.	76.	88.	108.	128.	151.	212.
INSTRUMENTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FERTILIZER	246.	244.	256.	297.	282.	328.	250.	312.	364.	433.	494.	590.
CASH GRAINS	3.	3.	3.	3.	4.	3.	4.	3.	3.	4.	4.	4.
COAL CONS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

ILLINOIS

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	662.	493.	753.	709.	625.	363.	351.	532.	623.	655.	677.	736.
MFG SHIPMENT	43442.	42476.	42043.	45417.	49689.	48699.	43762.	45905.	55977.	67195.	80120.	114675.
FOODS	2332.	2402.	2420.	2564.	2675.	3082.	2676.	2871.	3267.	3875.	4548.	6332.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	60.	57.	60.	67.	89.	80.	84.	91.	99.	110.	122.	151.
APPAREL	271.	273.	278.	263.	307.	297.	267.	289.	297.	318.	339.	388.
LUMBER	98.	105.	111.	128.	107.	125.	133.	147.	176.	224.	279.	443.
FURNITURE	240.	212.	219.	280.	320.	270.	225.	250.	291.	338.	388.	517.
PAPER PROD	581.	544.	536.	614.	706.	649.	520.	606.	726.	951.	1232.	2091.
PRINTING	1420.	1403.	1401.	1529.	1585.	1669.	1382.	1479.	1668.	2019.	2417.	3502.
CHEMICALS	1832.	2155.	2165.	2337.	2646.	2739.	2401.	2765.	3575.	4829.	6455.	11653.
PETROLEUM	286.	319.	243.	270.	421.	332.	467.	490.	536.	582.	627.	734.
RUBBER	621.	575.	604.	663.	746.	773.	622.	759.	1025.	1446.	2030.	4019.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	520.	516.	514.	584.	654.	597.	541.	608.	653.	768.	895.	1227.
PRIM METALS	1416.	1272.	1251.	1326.	1596.	1540.	1159.	1326.	1390.	1527.	1670.	2007.
FAB METALS	1952.	1737.	1717.	2088.	2315.	2296.	1780.	2021.	2411.	2978.	3633.	5475.
NONELEC MACH	3185.	2953.	2757.	3294.	3807.	4005.	3581.	3822.	4521.	5696.	7014.	10881.
ELEC MACH	3454.	2953.	3020.	3314.	3820.	3762.	2840.	3256.	4012.	5413.	7268.	13167.
TRANS EQUIP	892.	751.	877.	1162.	1194.	1422.	1132.	1290.	1558.	1834.	2158.	2988.
INSTRUMENTS	689.	586.	575.	705.	838.	885.	762.	857.	1041.	1364.	1758.	2969.
FERTILIZER	1589.	1526.	1622.	1475.	1583.	1813.	1772.	2102.	2325.	2757.	3145.	3757.
CASH GRAINS	36.	28.	38.	38.	37.	31.	46.	44.	46.	51.	55.	63.
COAL CONS	45244.	42310.	38289.	42028.	40628.	39054.	41948.	54288.	70047.	73603.	76491.	83528.
COAL PROD	64722.	65119.	58402.	65523.	61572.	58215.	59537.	57974.	62739.	65870.	68329.	74418.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

IOWA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	105.	100.	115.	125.	112.	105.	127.	174.	171.	193.	214.	269.
MFG SHIPMENT	9208.	9158.	8970.	10680.	12828.	11897.	11149.	11888.	14863.	18406.	22600.	34363.
FOODS	747.	778.	846.	911.	1036.	910.	994.	1088.	1312.	1639.	2018.	3103.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	2.	1.	1.	3.	3.	3.	3.	3.	4.	4.	5.	6.
APPAREL	-99.	-99.	-99.	27.	31.	31.	22.	30.	36.	46.	58.	92.
LUMBER	36.	40.	44.	52.	57.	53.	57.	70.	96.	134.	181.	342.
FURNITURE	50.	24.	37.	49.	52.	49.	51.	61.	75.	91.	108.	156.
PAPER PROD	67.	65.	72.	77.	85.	90.	69.	88.	108.	150.	207.	395.
PRINTING	170.	179.	163.	157.	173.	167.	149.	164.	197.	260.	339.	582.
CHEMICALS	206.	348.	375.	433.	539.	668.	685.	771.	1001.	1351.	1803.	3246.
PETROLEUM	4.	5.	-99.	5.	5.	4.	6.	7.	8.	9.	10.	13.
RUBBER	174.	147.	186.	244.	259.	284.	217.	258.	371.	532.	757.	1543.
LEATHER	-99.	-99.	-99.	6.	5.	10.	6.	7.	6.	6.	6.	6.
CLAY GLASS	94.	105.	92.	99.	-99.	119.	121.	458.	517.	648.	797.	1226.
PRIM METALS	105.	85.	80.	95.	121.	168.	102.	115.	127.	147.	168.	221.
FAB METALS	168.	165.	169.	222.	267.	278.	227.	267.	365.	504.	679.	1263.
NONELEC MACH	690.	654.	621.	941.	1193.	1290.	1123.	1220.	1632.	2287.	3087.	5841.
ELEC MACH	476.	430.	367.	436.	535.	552.	580.	660.	769.	1001.	1305.	2214.
TRANS EQUIP	86.	82.	112.	147.	155.	161.	140.	185.	242.	298.	367.	556.
INSTRUMENTS	23.	26.	25.	40.	45.	53.	28.	39.	55.	84.	123.	272.
FERTILIZER	1249.	1418.	1477.	1432.	1415.	1608.	1614.	2003.	2135.	2536.	2894.	3458.
CASH GRAINS	32.	30.	38.	41.	42.	33.	38.	38.	42.	48.	53.	61.
COAL CONS	5673.	6159.	6239.	6956.	6889.	6589.	6741.	6865.	7399.	8242.	9150.	11315.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

KANSAS

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	92.	96.	113.	133.	109.	79.	93.	138.	129.	137.	139.	150.
MFG SHIPMENT	5748.	5220.	5705.	6836.	7628.	7455.	7445.	7814.	9245.	11060.	13151.	18709.
FOODS	224.	259.	270.	359.	403.	427.	381.	411.	479.	576.	684.	977.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APPAREL	66.	72.	82.	59.	75.	39.	35.	51.	73.	102.	136.	253.
LUMBER	9.	7.	5.	42.	38.	31.	27.	34.	55.	82.	115.	241.
FURNITURE	17.	14.	16.	23.	26.	21.	20.	24.	29.	35.	40.	57.
PAPER PROD	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PRINTING	105.	150.	131.	107.	122.	154.	28.	31.	38.	49.	62.	103.
CHEMICALS	334.	333.	361.	352.	339.	410.	356.	402.	508.	673.	880.	1527.
PETROLEUM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RUBBER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	89.	78.	93.	120.	137.	139.	-99.	126.	141.	175.	215.	327.
PRIM METALS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FAB METALS	99.	103.	120.	118.	98.	116.	-99.	116.	143.	180.	224.	352.
NONELEC MACH	184.	184.	183.	257.	342.	430.	-99.	334.	442.	602.	789.	1406.
ELEC MACH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TRANS EQUIP	597.	436.	508.	639.	785.	686.	-99.	676.	846.	1018.	1223.	1768.
INSTRUMENTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FERTILIZER	571.	661.	630.	688.	794.	805.	788.	892.	1014.	1212.	1387.	1661.
CASH GRAINS	12.	12.	13.	14.	17.	14.	15.	15.	17.	19.	21.	26.
COAL CONS	1470.	1974.	2225.	2348.	3527.	3611.	5066.	4207.	4906.	6058.	7399.	11160.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

KENTUCKY

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	133.	141.	211.	222.	141.	83.	77.	107.	124.	172.	226.	411.
MFG SHIPMENT	8731.	8725.	9410.	10492.	11378.	11218.	10266.	11259.	14041.	17366.	21282.	32257.
FOODS	552.	495.	526.	576.	613.	573.	502.	576.	691.	875.	1095.	1733.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	44.	29.	37.	100.	110.	99.	87.	107.	128.	158.	194.	294.
APPAREL	133.	169.	181.	176.	216.	215.	220.	293.	331.	430.	543.	892.
LUMBER	68.	57.	58.	89.	89.	91.	91.	111.	141.	188.	245.	424.
FURNITURE	42.	36.	43.	41.	48.	40.	36.	43.	45.	49.	53.	63.
PAPER PROD	68.	70.	82.	101.	119.	150.	124.	148.	184.	256.	351.	670.
PRINTING	148.	166.	166.	121.	125.	155.	135.	134.	176.	240.	318.	575.
CHEMICALS	481.	457.	448.	542.	601.	665.	598.	681.	858.	1143.	1510.	2656.
PETROLEUM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RUBBER	99.	116.	151.	135.	164.	194.	154.	183.	283.	426.	633.	1412.
LEATHER	-99.	-99.	-99.	42.	46.	41.	35.	37.	33.	33.	33.	32.
CLAY GLASS	82.	86.	90.	140.	146.	141.	118.	151.	182.	261.	362.	723.
PRIM METALS	195.	184.	249.	275.	292.	319.	267.	287.	394.	529.	688.	1203.
FAB METALS	196.	176.	194.	220.	252.	244.	215.	244.	307.	398.	507.	835.
NONELEC MACH	487.	480.	570.	535.	694.	818.	704.	733.	1000.	1388.	1856.	3445.
ELEC MACH	724.	652.	908.	808.	906.	906.	665.	759.	1084.	1665.	2511.	5818.
TRANS EQUIP	238.	221.	260.	389.	531.	647.	420.	489.	678.	867.	1102.	1793.
INSTRUMENTS	38.	34.	58.	64.	63.	67.	61.	65.	80.	103.	130.	211.
FERTILIZER	315.	302.	334.	329.	348.	376.	346.	431.	470.	556.	634.	757.
CASH GRAINS	3.	2.	3.	3.	3.	4.	4.	5.	5.	5.	5.	6.
COAL CONS	20355.	23672.	25590.	27389.	25078.	25445.	28480.	36797.	57144.	69584.	82547.	119244.
COAL PROD	109050.	125305.	119389.	112187.	127645.	137197.	143613.	140000.	143558.	149096.	158724.	175350.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

LOUISIANA	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	172.	169.	315.	330.	230.	126.	109.	150.	144.	196.	245.	418.
MFG SHIPMENT	8102.	8037.	8185.	9574.	10282.	12734.	12853.	13189.	16050.	19281.	23006.	32977.
FOODS	391.	423.	448.	475.	492.	691.	454.	487.	583.	722.	881.	1330.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	-99.	-99.	-99.	14.	27.	28.	34.	39.	45.	53.	61.	84.
APPAREL	49.	45.	46.	53.	68.	71.	69.	87.	99.	115.	131.	172.
LUMBER	109.	98.	101.	151.	143.	113.	133.	162.	209.	277.	357.	610.
FURNITURE	-99.	-99.	-99.	12.	13.	7.	8.	9.	12.	16.	19.	31.
PAPER PROD	279.	295.	300.	339.	390.	436.	310.	345.	395.	486.	593.	891.
PRINTING	79.	69.	66.	86.	103.	87.	78.	86.	107.	126.	147.	203.
CHEMICALS	978.	1061.	1111.	1500.	1751.	2702.	2355.	2624.	3332.	4371.	5684.	9697.
PETROLEUM	358.	322.	282.	291.	312.	489.	700.	705.	729.	750.	770.	814.
RUBBER	5.	5.	8.	11.	11.	10.	10.	12.	19.	28.	42.	93.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	97.	95.	88.	96.	92.	96.	100.	107.	113.	129.	145.	185.
PRIM METALS	87.	58.	73.	99.	108.	116.	112.	127.	155.	191.	232.	348.
FAB METALS	116.	119.	134.	155.	162.	143.	158.	181.	227.	253.	281.	349.
NONELEC MACH	65.	59.	66.	97.	96.	125.	133.	133.	150.	173.	196.	257.
ELEC MACH	75.	81.	101.	156.	193.	192.	147.	149.	207.	319.	481.	1118.
TRANS EQUIP	162.	180.	182.	270.	329.	299.	422.	483.	587.	693.	819.	1142.
INSTRUMENTS	5.	7.	7.	7.	6.	7.	4.	4.	5.	7.	9.	15.
FERTILIZER	207.	223.	249.	267.	241.	291.	230.	251.	315.	375.	428.	511.
CASH GRAINS	1.	1.	1.	1.	1.	1.	2.	2.	2.	2.	3.	3.
COAL CONS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

MINNESOTA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	280.	223.	262.	303.	229.	175.	152.	225.	254.	192.	148.	86.
MFG SHIPMENT	10696.	9972.	9841.	10939.	12129.	11878.	10931.	11453.	14011.	17027.	20537.	30103.
FOODS	664.	647.	697.	757.	886.	919.	790.	867.	1012.	1241.	1505.	2238.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	19.	16.	20.	31.	35.	32.	23.	27.	30.	33.	38.	48.
APPAREL	55.	43.	38.	52.	58.	126.	76.	105.	125.	160.	199.	318.
LUMBER	61.	63.	83.	104.	109.	113.	129.	182.	265.	411.	613.	1417.
FURNITURE	39.	35.	37.	43.	45.	40.	36.	43.	51.	61.	72.	101.
PAPER PROD	398.	383.	393.	437.	496.	397.	334.	416.	541.	785.	1117.	2307.
PRINTING	282.	272.	285.	277.	313.	328.	290.	304.	357.	441.	536.	805.
CHEMICALS	279.	269.	247.	297.	302.	342.	279.	318.	382.	489.	621.	1009.
PETROLEUM	54.	46.	43.	49.	92.	61.	109.	119.	137.	157.	177.	228.
RUBBER	-99.	-99.	-99.	124.	158.	157.	164.	196.	281.	403.	573.	1169.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	88.	84.	88.	99.	99.	137.	138.	525.	594.	741.	913.	1404.
PRIM METALS	80.	92.	75.	89.	102.	107.	81.	91.	119.	157.	200.	338.
FAB METALS	271.	205.	211.	425.	468.	493.	392.	471.	646.	901.	1225.	2324.
NONELEC MACH	949.	818.	799.	891.	1197.	1333.	931.	1184.	1557.	2140.	2840.	5178.
ELEC MACH	414.	385.	292.	382.	534.	563.	547.	625.	760.	1077.	1521.	3041.
TRANS EQUIP	149.	179.	173.	207.	217.	186.	160.	168.	244.	318.	411.	692.
INSTRUMENTS	135.	150.	155.	185.	211.	224.	200.	200.	254.	332.	425.	712.
FERTILIZER	841.	721.	977.	895.	993.	1004.	1069.	1234.	1350.	1601.	1826.	2181.
CASH GRAINS	13.	14.	17.	17.	21.	15.	17.	15.	20.	23.	25.	28.
COAL CONS	8100.	8769.	8313.	8639.	9161.	9668.	11033.	12076.	15637.	17997.	20475.	26810.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

MISSISSIPPI

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	74.	109.	126.	166.	156.	76.	48.	59.	88.	258.	642.	4664.
MFG SHIPMENT	4213.	4398.	4623.	5545.	6227.	5901.	5543.	6311.	8216.	10517.	13297.	21523.
FOODS	145.	158.	162.	183.	246.	236.	220.	248.	292.	362.	442.	668.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	63.	69.	70.	82.	111.	125.	115.	129.	146.	170.	196.	262.
APPAREL	169.	172.	196.	216.	262.	281.	259.	353.	393.	508.	638.	1036.
LUMBER	175.	196.	169.	212.	231.	184.	165.	210.	281.	401.	557.	1104.
FURNITURE	89.	85.	105.	132.	149.	121.	109.	106.	132.	185.	254.	489.
PAPER PROD	127.	130.	132.	145.	147.	160.	159.	175.	197.	242.	296.	447.
PRINTING	25.	29.	27.	28.	28.	40.	43.	43.	51.	64.	78.	117.
CHEMICALS	164.	183.	229.	249.	270.	338.	286.	328.	431.	590.	799.	1479.
PETROLEUM	-99.	-99.	-99.	55.	207.	121.	119.	127.	144.	160.	177.	218.
RUBBER	63.	57.	69.	93.	108.	80.	65.	61.	97.	205.	425.	1055.
LEATHER	22.	16.	15.	18.	18.	19.	19.	21.	18.	18.	18.	18.
CLAY GLASS	60.	54.	65.	88.	95.	101.	89.	99.	102.	159.	240.	562.
PRIM METALS	20.	18.	18.	32.	43.	39.	26.	30.	57.	92.	138.	333.
FAB METALS	96.	90.	81.	142.	150.	133.	107.	126.	172.	252.	358.	744.
NONELEC MACH	94.	102.	98.	120.	136.	146.	127.	141.	191.	267.	362.	686.
ELEC MACH	157.	189.	205.	263.	299.	335.	268.	291.	434.	690.	1072.	2647.
TRANS EQUIP	96.	168.	161.	250.	298.	433.	362.	408.	483.	566.	664.	911.
INSTRUMENTS	26.	17.	14.	23.	20.	24.	19.	20.	25.	32.	40.	65.
FERTILIZER	274.	281.	294.	366.	376.	397.	318.	324.	425.	506.	578.	691.
CASH GRAINS	2.	2.	2.	2.	2.	2.	2.	3.	3.	3.	3.	3.
COAL CONS	25582.	27198.	27694.	30064.	27695.	26719.	29798.	39455.	53287.	59881.	66436.	82830.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

MISSOURI

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	221.	205.	303.	315.	239.	145.	151.	212.	214.	252.	296.	409.
MFG SHIPMENT	15322.	14547.	15083.	15922.	17063.	15264.	13658.	15083.	18128.	21532.	25410.	35617.
FOODS	720.	729.	775.	829.	962.	894.	783.	935.	1185.	1533.	1948.	3201.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APPAREL	177.	202.	225.	228.	249.	267.	224.	308.	355.	445.	547.	844.
LUMBER	52.	62.	71.	82.	76.	72.	64.	77.	110.	159.	220.	438.
FURNITURE	50.	41.	53.	83.	93.	80.	73.	88.	107.	129.	154.	222.
PAPER PROD	155.	154.	177.	171.	199.	216.	-99.	222.	271.	355.	460.	779.
PRINTING	399.	420.	405.	445.	438.	513.	323.	368.	477.	644.	850.	1513.
CHEMICALS	602.	650.	723.	803.	889.	1012.	810.	962.	1287.	1779.	2429.	4584.
PETROLEUM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RUBBER	139.	108.	130.	150.	199.	174.	149.	178.	255.	366.	520.	1061.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	200.	188.	171.	201.	214.	210.	180.	682.	772.	964.	1187.	1825.
PRIM METALS	198.	173.	183.	238.	294.	330.	214.	262.	332.	419.	520.	815.
FAB METALS	366.	348.	310.	456.	477.	494.	356.	502.	732.	1039.	1436.	2816.
NONELEC MACH	432.	390.	400.	439.	497.	501.	441.	484.	589.	748.	928.	1462.
ELEC MACH	503.	572.	582.	605.	666.	678.	626.	682.	923.	1351.	1950.	4121.
TRANS EQUIP	1391.	1250.	1685.	1893.	2077.	2024.	2443.	2602.	3388.	4169.	5105.	7691.
INSTRUMENTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FERTILIZER	577.	659.	686.	736.	654.	759.	643.	840.	917.	1088.	1241.	1483.
CASH GRAINS	8.	8.	11.	11.	11.	8.	10.	9.	11.	12.	13.	15.
COAL CONS	11098.	13397.	13358.	15810.	17385.	17844.	19241.	17074.	19274.	22574.	26326.	35958.
COAL PROD	3301.	4447.	4036.	4551.	4658.	4623.	5638.	5415.	6448.	8765.	11767.	21471.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

NEBRASKA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	68.	69.	110.	125.	95.	64.	65.	88.	77.	84.	89.	103.
MFG SHIPMENT	4189.	4019.	4232.	5001.	5525.	5182.	4901.	5359.	7138.	9335.	12043.	20321.
FOODS	412.	402.	442.	476.	561.	561.	540.	597.	731.	922.	1146.	1797.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	-99.	-99.	-99.	4.	3.	5.	6.	7.	7.	8.	9.	12.
APPAREL	11.	9.	11.	14.	14.	18.	13.	19.	22.	28.	35.	56.
LUMBER	12.	11.	13.	22.	20.	21.	20.	27.	39.	57.	80.	165.
FURNITURE	18.	19.	20.	23.	26.	23.	17.	21.	30.	38.	47.	73.
PAPER PROD	-99.	-99.	-99.	16.	19.	16.	11.	20.	25.	36.	49.	95.
PRINTING	50.	54.	57.	64.	65.	60.	69.	72.	84.	102.	122.	177.
CHEMICALS	72.	78.	91.	103.	123.	169.	185.	202.	242.	302.	377.	587.
PETROLEUM	-99.	-99.	-99.	5.	-99.	5.	7.	8.	9.	10.	11.	14.
RUBBER	-99.	-99.	-99.	64.	81.	79.	58.	69.	98.	141.	201.	409.
LEATHER	-99.	-99.	-99.	-99.	-99.	-99.	2.	2.	2.	2.	2.	2.
CLAY GLASS	33.	22.	25.	40.	40.	54.	51.	66.	76.	96.	119.	186.
PRIM METALS	46.	75.	44.	60.	53.	45.	45.	47.	70.	99.	133.	255.
FAB METALS	63.	90.	75.	85.	96.	97.	69.	84.	109.	143.	185.	315.
NONELEC MACH	136.	149.	150.	150.	165.	186.	164.	164.	250.	374.	531.	1127.
ELEC MACH	141.	136.	150.	185.	207.	210.	178.	198.	279.	423.	630.	1424.
TRANS EQUIP	78.	69.	73.	64.	110.	123.	59.	66.	116.	166.	232.	461.
INSTRUMENTS	60.	50.	58.	68.	72.	87.	88.	96.	131.	184.	250.	477.
FERTILIZER	568.	667.	729.	743.	778.	793.	647.	857.	940.	1124.	1287.	1542.
CASH GRAINS	15.	14.	16.	18.	19.	15.	18.	18.	20.	23.	26.	30.
COAL CONS	1470.	1974.	2225.	2348.	3527.	3611.	5066.	4207.	4906.	6058.	7399.	11160.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

OHIO

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	550.	508.	760.	789.	568.	402.	344.	434.	526.	634.	726.	1002.
MFG SHIPMENT	46286.	42885.	43977.	46690.	50832.	48557.	42972.	45419.	52518.	61748.	72264.	99434.
FOODS	1217.	1280.	1319.	1424.	1530.	1618.	1478.	1576.	1860.	2275.	2744.	4049.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	90.	97.	127.	147.	184.	156.	132.	146.	172.	206.	243.	345.
APPAREL	172.	162.	188.	232.	273.	251.	231.	290.	310.	367.	428.	592.
LUMBER	119.	105.	109.	143.	147.	152.	135.	160.	203.	268.	346.	589.
FURNITURE	198.	178.	188.	203.	222.	206.	197.	211.	225.	246.	267.	316.
PAPER PROD	578.	540.	517.	573.	653.	611.	416.	489.	553.	727.	947.	1623.
PRINTING	767.	772.	740.	843.	873.	923.	700.	752.	839.	981.	1140.	1549.
CHEMICALS	1844.	1937.	2026.	2195.	2258.	2506.	1931.	2223.	3089.	4412.	6198.	12433.
PETROLEUM	182.	174.	166.	205.	211.	234.	396.	403.	428.	453.	476.	530.
RUBBER	1660.	1541.	1696.	1943.	2242.	2087.	1515.	1951.	3317.	5598.	9244.	25756.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	890.	777.	810.	943.	1014.	1002.	856.	985.	1061.	1316.	1607.	2432.
PRIM METALS	2617.	2241.	2104.	2161.	2801.	2855.	1950.	2265.	2470.	2823.	3214.	4181.
FAB METALS	2161.	1913.	1991.	2328.	2636.	2656.	2077.	2402.	3074.	4034.	5196.	8781.
NONELEC MACH	3058.	2735.	2495.	3073.	3503.	3764.	2932.	3220.	3906.	5020.	6289.	10124.
ELEC MACH	2883.	2639.	2374.	2449.	2636.	2689.	2311.	2564.	3068.	4152.	5597.	10212.
TRANS EQUIP	3115.	2695.	3193.	3579.	4354.	4312.	3653.	4070.	5171.	6276.	7595.	11156.
INSTRUMENTS	152.	181.	192.	252.	310.	318.	263.	296.	408.	579.	798.	1560.
FERTILIZER	638.	675.	764.	740.	754.	870.	810.	956.	1075.	1272.	1449.	1730.
CASH GRAINS	10.	10.	13.	12.	10.	12.	14.	16.	15.	17.	19.	22.
COAL CONS	62160.	67375.	63116.	67795.	65557.	69642.	68019.	68394.	74938.	86419.	99007.	130808.
COAL PROD	51242.	55351.	51431.	50967.	45783.	45409.	46770.	45484.	51366.	55686.	59789.	69593.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

OKLAHOMA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	143.	160.	252.	259.	152.	103.	88.	134.	162.	279.	446.	1231.
MFG SHIPMENT	3653.	3904.	3993.	4534.	5029.	5173.	5189.	5565.	7376.	9452.	11952.	19365.
FOODS	154.	179.	190.	196.	235.	258.	218.	230.	291.	364.	447.	688.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	-99.	-99.	-99.	23.	24.	20.	16.	18.	21.	25.	29.	39.
APPAREL	36.	40.	54.	60.	82.	104.	97.	136.	157.	205.	259.	429.
LUMBER	17.	14.	17.	51.	45.	27.	25.	40.	91.	141.	205.	462.
FURNITURE	11.	23.	26.	16.	21.	16.	12.	9.	19.	29.	42.	96.
PAPER PROD	20.	21.	22.	39.	46.	59.	40.	49.	62.	83.	110.	196.
PRINTING	70.	82.	86.	90.	104.	103.	98.	104.	130.	170.	218.	364.
CHEMICALS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PETROLEUM	99.	85.	64.	60.	76.	109.	253.	261.	268.	276.	285.	302.
RUBBER	83.	90.	113.	135.	187.	196.	199.	243.	379.	541.	757.	1510.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	101.	99.	108.	135.	135.	107.	118.	140.	160.	206.	259.	421.
PRIM METALS	36.	34.	41.	-99.	-99.	94.	41.	47.	57.	71.	86.	129.
FAB METALS	157.	155.	141.	165.	165.	220.	165.	184.	230.	294.	371.	599.
NONELEC MACH	221.	257.	241.	372.	415.	416.	449.	461.	657.	924.	1246.	2361.
ELEC MACH	132.	180.	185.	218.	225.	203.	191.	190.	322.	504.	759.	1788.
TRANS EQUIP	188.	165.	138.	140.	182.	237.	197.	230.	292.	350.	415.	588.
INSTRUMENTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FERTILIZER	253.	290.	304.	308.	351.	350.	307.	362.	418.	498.	569.	681.
CASH GRAINS	4.	3.	2.	3.	5.	4.	5.	5.	5.	6.	6.	6.
COAL CONS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COAL PROD	1838.	2427.	2234.	2624.	2183.	2356.	2872.	3299.	3140.	4274.	5733.	10466.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

PENNSYLVANIA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	379.	337.	456.	487.	471.	323.	293.	355.	383.	411.	436.	495.
MFG SHIPMENT	41520.	39507.	39208.	40954.	44121.	44054.	38670.	39377.	47088.	56032.	66266.	93256.
FOODS	93.	1452.	1532.	1703.	1861.	1964.	1668.	1714.	1897.	2163.	2445.	3152.
TOBACCO	112.	128.	117.	101.	91.	95.	73.	79.	79.	85.	93.	109.
TEXTILE MILL	575.	633.	669.	688.	846.	740.	675.	729.	827.	958.	1098.	1458.
APPAREL	1018.	923.	982.	1015.	1176.	1163.	980.	1176.	1243.	1434.	1633.	2147.
LUMBER	130.	146.	158.	233.	202.	235.	196.	214.	253.	310.	374.	553.
FURNITURE	256.	221.	217.	234.	248.	242.	186.	205.	212.	241.	271.	347.
PAPER PROD	680.	689.	692.	672.	750.	782.	610.	681.	775.	998.	1274.	2094.
PRINTING	741.	700.	681.	814.	850.	952.	810.	878.	932.	1027.	1129.	1369.
CHEMICALS	1845.	1802.	1800.	1973.	2190.	2268.	1798.	2077.	2747.	3779.	5137.	9607.
PETROLEUM	205.	161.	278.	230.	188.	189.	154.	165.	186.	208.	229.	282.
RUBBER	525.	525.	549.	633.	710.	686.	502.	608.	894.	1304.	1883.	3967.
LEATHER	157.	157.	155.	171.	176.	173.	154.	166.	136.	136.	135.	133.
CLAY GLASS	780.	708.	712.	837.	894.	850.	730.	820.	882.	1041.	1217.	1678.
PRIM METALS	3191.	2756.	2688.	2528.	3268.	3886.	2844.	3083.	3294.	3790.	4333.	5701.
FAB METALS	1411.	1332.	1287.	1350.	1540.	1656.	1307.	1421.	1606.	1873.	2169.	2930.
NONELEC MACH	1899.	1778.	1712.	1845.	2160.	2221.	1969.	2102.	2537.	3185.	3912.	6032.
ELEC MACH	2564.	2280.	2165.	2369.	2545.	2476.	2058.	2325.	2741.	3748.	5102.	9497.
TRANS EQUIP	1380.	1203.	1202.	1266.	1457.	1505.	1332.	1490.	1931.	2373.	2905.	4369.
INSTRUMENTS	444.	418.	408.	500.	559.	653.	628.	698.	813.	1028.	1287.	2036.
FERTILIZER	229.	250.	263.	242.	265.	265.	228.	277.	313.	370.	422.	503.
CASH GRAINS	2.	3.	2.	2.	3.	3.	3.	3.	3.	3.	3.	4.
COAL CONS	59661.	63009.	58982.	64518.	64469.	63323.	63390.	68293.	76208.	83186.	90443.	107336.
COAL PROD	78631.	80491.	72835.	75939.	76403.	80462.	84137.	83654.	91131.	110780.	134137.	197438.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

TENNESSEE

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	194.	217.	314.	396.	344.	171.	126.	164.	264.	391.	523.	1036.
MFG SHIPMENT	11888.	11806.	12345.	13697.	15021.	14082.	12707.	13743.	17063.	21177.	26021.	39682.
FOODS	439.	479.	501.	566.	658.	713.	621.	664.	785.	1010.	1275.	2069.
TOBACCO	12.	12.	11.	24.	18.	17.	18.	19.	19.	21.	22.	26.
TEXTILE MILL	269.	289.	336.	337.	397.	357.	336.	359.	405.	483.	567.	794.
APPAREL	326.	351.	355.	464.	538.	520.	501.	681.	729.	918.	1132.	1758.
LUMBER	94.	88.	93.	142.	135.	108.	112.	134.	158.	207.	267.	452.
FURNITURE	157.	148.	167.	214.	226.	196.	161.	190.	238.	300.	369.	572.
PAPER PROD	235.	243.	263.	308.	354.	341.	261.	295.	352.	485.	657.	1227.
PRINTING	167.	184.	185.	191.	223.	256.	216.	230.	262.	318.	382.	558.
CHEMICALS	1459.	1429.	1520.	1551.	1724.	1705.	1506.	1736.	2241.	3051.	4107.	7530.
PETROLEUM	11.	13.	14.	12.	13.	21.	32.	34.	38.	43.	47.	58.
RUBBER	231.	266.	298.	402.	467.	416.	346.	391.	644.	1065.	1719.	4586.
LEATHER	133.	131.	136.	160.	180.	187.	182.	195.	171.	171.	170.	168.
CLAY GLASS	215.	209.	222.	269.	293.	274.	220.	270.	296.	406.	541.	989.
PRIM METALS	232.	190.	177.	189.	269.	279.	184.	213.	247.	304.	369.	552.
FAB METALS	274.	262.	264.	329.	383.	362.	330.	381.	503.	683.	907.	1637.
NONELEC MACH	272.	340.	344.	405.	535.	584.	439.	398.	654.	1050.	1579.	3814.
ELEC MACH	614.	585.	667.	744.	773.	658.	550.	666.	938.	1433.	2153.	4943.
TRANS EQUIP	238.	286.	280.	355.	365.	493.	285.	305.	531.	751.	1042.	2044.
INSTRUMENTS	27.	31.	34.	40.	39.	52.	46.	48.	59.	76.	97.	157.
FERTILIZER	293.	271.	289.	296.	311.	317.	269.	314.	367.	434.	495.	590.
CASH GRAINS	2.	2.	2.	2.	2.	2.	3.	3.	3.	3.	4.	4.
COAL CONS	16793.	18315.	18907.	21390.	22238.	18916.	26633.	29948.	42171.	48349.	54574.	70624.
COAL PROD	8082.	8237.	9271.	11260.	8219.	7541.	8206.	8755.	9645.	10979.	12420.	15993.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

W. VIRGINIA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	26.	25.	32.	22.	22.	10.	14.	19.	18.	16.	14.	10.
MFG SHIPMENT	4087.	4066.	4000.	4253.	4453.	4493.	3959.	3918.	4483.	5110.	5806.	7519.
FOODS	73.	72.	72.	76.	83.	71.	68.	69.	72.	79.	87.	105.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	8.	13.	11.	8.	13.	10.	9.	9.	9.	10.	11.	12.
APPAREL	15.	24.	24.	26.	31.	26.	34.	44.	46.	56.	69.	103.
LUMBER	31.	30.	27.	43.	41.	36.	42.	48.	53.	60.	68.	88.
FURNITURE	8.	8.	7.	8.	9.	9.	7.	8.	10.	13.	15.	23.
PAPER PROD	17.	17.	13.	23.	29.	23.	17.	20.	23.	29.	36.	58.
PRINTING	78.	47.	46.	50.	52.	47.	36.	44.	44.	53.	63.	90.
CHEMICALS	913.	910.	924.	1055.	1164.	1187.	852.	1040.	1232.	1548.	1942.	3063.
PETROLEUM	5.	8.	6.	17.	15.	22.	23.	25.	29.	33.	37.	46.
RUBBER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	240.	229.	243.	255.	268.	244.	222.	251.	275.	335.	403.	589.
PRIM METALS	397.	373.	355.	365.	365.	368.	277.	284.	296.	313.	329.	365.
FAB METALS	81.	83.	78.	94.	104.	120.	92.	101.	113.	129.	148.	194.
NONELEC MACH	55.	58.	61.	62.	75.	108.	99.	92.	80.	95.	114.	163.
ELEC MACH	127.	124.	127.	119.	135.	158.	128.	140.	186.	274.	398.	853.
TRANS EQUIP	-99.	-99.	-99.	54.	59.	66.	66.	73.	95.	119.	147.	227.
INSTRUMENTS	8.	35.	36.	40.	43.	46.	42.	44.	59.	87.	124.	260.
FERTILIZER	23.	25.	25.	28.	26.	27.	19.	25.	29.	34.	39.	46.
CASH GRAINS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COAL CONS	24356.	24395.	26606.	32459.	32305.	33784.	34360.	37324.	45589.	57686.	72065.	113918.
COAL PROD	141011.	144072.	118258.	123743.	115448.	102462.	109283.	108863.	106351.	103044.	99833.	93713.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

WISCONSIN

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	192.	201.	267.	287.	289.	218.	214.	290.	211.	221.	215.	220.
MFG SHIPMENT	16759.	15849.	16512.	18025.	19980.	19291.	18255.	19566.	23396.	27566.	32299.	44590.
FOODS	892.	921.	996.	1087.	1190.	1236.	1191.	1278.	1521.	1876.	2282.	3424.
TOBACCO	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TEXTILE MILL	91.	88.	85.	102.	90.	79.	80.	87.	99.	115.	132.	177.
APPAREL	58.	59.	59.	59.	78.	111.	60.	76.	87.	113.	142.	233.
LUMBER	115.	113.	116.	180.	179.	189.	192.	221.	267.	336.	415.	646.
FURNITURE	74.	69.	77.	95.	103.	100.	82.	91.	112.	136.	162.	236.
PAPER PROD	705.	659.	680.	724.	802.	861.	684.	771.	871.	1063.	1290.	1908.
PRINTING	289.	277.	273.	290.	315.	318.	320.	345.	384.	449.	521.	708.
CHEMICALS	350.	305.	388.	420.	422.	415.	354.	421.	587.	844.	1192.	2418.
PETROLEUM	-99.	-99.	-99.	8.	19.	5.	18.	19.	21.	23.	25.	30.
RUBBER	159.	171.	163.	220.	271.	287.	229.	268.	375.	527.	736.	1447.
LEATHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CLAY GLASS	121.	103.	103.	126.	133.	157.	127.	151.	159.	185.	213.	286.
PRIM METALS	362.	330.	304.	285.	354.	340.	317.	357.	402.	456.	511.	649.
FAB METALS	595.	538.	505.	724.	811.	783.	670.	770.	993.	1310.	1694.	2890.
NONELEC MACH	1521.	1436.	1375.	1554.	1814.	1947.	1760.	1895.	2282.	2861.	3511.	5403.
ELEC MACH	854.	800.	820.	891.	954.	1221.	980.	1119.	1275.	1551.	1893.	2811.
TRANS EQUIP	586.	464.	808.	738.	948.	1045.	1033.	1138.	1315.	1498.	1707.	2215.
INSTRUMENTS	113.	106.	114.	99.	130.	164.	149.	162.	190.	233.	283.	422.
FERTILIZER	425.	433.	467.	493.	477.	551.	501.	606.	679.	802.	913.	1089.
CASH GRAINS	4.	6.	6.	6.	5.	5.	6.	4.	5.	5.	6.	7.
COAL CONS	14972.	17308.	15340.	14978.	12634.	12335.	14075.	20008.	26887.	27982.	28765.	30775.
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

INDIANNA

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	272.	223.	309.	339.	356.	204.	181.	250.	305.	405.	0.	510.
MFG SHIPMENT	23643.	21874.	22227.	24748.	27136.	25711.	22287.	24301.	29172.	34689.	41030.	57708.
FOODS	665.	709.	765.	797.	805.	897.	792.	838.	968.	1161.	1375.	1954.
TOBACCO	*	*	*	*	*	*	*	*	*	*	*	*
TEXTILE MILL	*	*	*	*	*	*	*	*	*	*	*	*
APPAREL	*	*	*	*	*	*	*	*	*	*	*	*
LUMBER	96.	104.	111.	253.	225.	196.	185.	226.	320.	457.	630.	1243.
FURNITURE	*	*	*	*	*	*	*	*	*	*	*	*
PAPER PROD	185.	178.	177.	192.	202.	201.	166.	192.	216.	265.	323.	481.
PRINTING	*	*	*	*	*	*	*	*	*	*	*	*
CHEMICALS	1142.	1158.	1212.	1383.	1517.	1662.	1321.	1511.	2067.	2915.	4048.	7931.
PETROLEUM	184.	184.	144.	139.	308.	209.	74.	89.	118.	147.	179.	271.
RUBBER	*	*	*	*	*	*	*	*	*	*	*	*
LEATHER	*	*	*	*	*	*	*	*	*	*	*	*
CLAY GLASS	*	*	*	*	*	*	*	*	*	*	*	*
PRIM METALS	1438.	1418.	1331.	1501.	1846.	1931.	1175.	1377.	1452.	1577.	1712.	2019.
FAB METALS	729.	605.	630.	823.	970.	970.	724.	841.	1108.	1488.	1955.	3449.
NONELEC MACH	*	*	*	*	*	*	*	*	*	*	*	*
ELEC MACH	*	*	*	*	*	*	*	*	*	*	*	*
TRANS EQUIP	*	*	*	*	*	*	*	*	*	*	*	*
INSTRUMENTS	*	*	*	*	*	*	*	*	*	*	*	*
FERTILIZER	871.	893.	993.	893.	930.	1058.	863.	1098.	1234.	1461.	1665.	1987.
CASH GRAINS	17.	14.	20.	19.	20.	15.	21.	24.	22.	26.	30.	35.
COAL CONS	41299.	42385.	38599.	46618.	45061.	43921.	46928.	51202.	61156.	67099.	73105.	87390.
COAL PROD	20086.	22263.	23669.	25949.	25253.	23726.	25124.	24136.	31278.	42880.	58076.	107834.
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	114.	139.	164.	191.

OTHER US

	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990	2000
HOUSE STARTS	1.	1.	3.	2.	2.	1.	1.	2.	2.	2.	3.	3.
MFG SHIPMENT	282.	271.	275.	302.	330.	329.	296.	329.	405.	497.	602.	890.
FOODS	106.	107.	110.	115.	115.	120.	122.	127.	143.	164.	185.	228.
TOBACCO	*	*	*	*	*	*	*	*	*	*	*	*
TEXTILE MILL	*	*	*	*	*	*	*	*	*	*	*	*
APPAREL	*	*	*	*	*	*	*	*	*	*	*	*
LUMBER	16.	17.	17.	20.	20.	19.	16.	18.	22.	28.	33.	44.
FURNITURE	*	*	*	*	*	*	*	*	*	*	*	*
PAPER PROD	26.	25.	25.	28.	30.	30.	27.	29.	35.	42.	50.	68.
PRINTING	*	*	*	*	*	*	*	*	*	*	*	*
CHEMICALS	49.	49.	50.	57.	62.	63.	57.	63.	79.	102.	133.	200.
PETROLEUM	33.	34.	35.	37.	39.	38.	37.	39.	42.	47.	51.	59.
RUBBER	*	*	*	*	*	*	*	*	*	*	*	*
LEATHER	*	*	*	*	*	*	*	*	*	*	*	*
CLAY GLASS	*	*	*	*	*	*	*	*	*	*	*	*
PRIM METALS	60.	55.	53.	57.	65.	63.	53.	59.	70.	81.	95.	126.
FAB METALS	45.	42.	43.	48.	51.	47.	44.	48.	57.	69.	82.	109.
NONELEC MACH	*	*	*	*	*	*	*	*	*	*	*	*
ELEC MACH	*	*	*	*	*	*	*	*	*	*	*	*
TRANS EQUIP	*	*	*	*	*	*	*	*	*	*	*	*
INSTRUMENTS	*	*	*	*	*	*	*	*	*	*	*	*
FERTILIZER	15515.	16068.	17168.	17213.	18029.	19338.	17561.	20802.	23181.	27141.	30680.	36261.
CASH GRAINS	209.	191.	242.	241.	256.	221.	272.	276.	290.	329.	365.	424.
COAL CONS	*	*	*	*	*	*	*	*	*	*	*	*
COAL PROD	*	*	*	*	*	*	*	*	*	*	*	*
GRAIN EXP	45.	56.	53.	68.	100.	85.	92.	103.	0.	0.	0.	0.

APPENDIX D

SECTION II

HISTORICAL AND FORECAST PRODUCTION AND CONSUMPTION OF COARSE GRAINS, WHEAT, OILSEEDS AND MEALS, U.S. AND WORLD

WORLD COARSE GRAIN SUPPLY AND UTILIZATION

(millions of metric tons, crops years)

	Average 1961-1963	1974	1975	1976	Est. 1977	Forecast 1978	1980	1985	2000
PRODUCTION									
World	444.6	660.9	620.4	634.4	691.2	695.6	758.0	872.9	1264.2
U.S.	133.0	186.6	150.5	184.9	193.1	198.5	211.8	270.0	372.6
U.S. %	29.9	28.2	24.3	29.1	27.9	28.5	27.9	30.9	29.5
EXPORTS									
World	31.9	71.1	63.7	77.1	83.0	74.3	82.8	100.1	185.8
U.S.	15.3	44.5	34.3	46.5	51.8	46.1	46.4	43.4	93.8
U.S. %	48.0	62.6	53.8	60.3	62.4	62.0	56.0	43.4	50.5
CONSUMPTION									
World	444.8	661.8	625.8	634.2	672.7	678.1	760.7	864.0	1251.3
U.S.	122.5	155.6	121.4	133.5	130.2	137.7	153.2	192.5	278.8
U.S. %	27.5	23.5	19.4	21.1	19.4	20.3	20.1	22.3	22.2
ENDING STOCKS									
World	96.4	56.2	52.0	52.2	70.7	85.8	70.0	55.9	81.0
U.S.	70.3	21.8	15.4	17.4	30.6	40.5	32.0	21.9	22.6
U.S. %	72.9	38.8	29.6	33.3	43.3	47.2	45.7	39.1	27.9

WORLD WHEAT SUPPLY AND UTILIZATION

(millions of metric tons, crop years)

	Average 1961-1963	1974	1975	1976	Est. 1977	Forecast 1978	1980	1985	2000
PRODUCTION									
World	241.2	371.6	356.4	349.3	412.7	398.0	435.7	490.5	643.0
U.S.	33.4	46.4	48.9	58.1	58.4	56.0	56.7	73.1	90.0
U.S.	13.8	12.5	13.7	16.6	14.2	14.1	13.0	14.9	14.0
EXPORTS									
World	49.3	62.6	63.9	65.8	61.4	69.1	79.3	105.3	131.5
U.S.	20.3	31.1	28.0	31.5	25.4	30.4	32.5	42.0	51.8
U.S. %	41.2	49.7	43.8	47.9	41.4	44.0	41.0	39.9	39.4
CONSUMPTION									
World	239.5	363.5	363.0	349.1	375.4	397.2	439.5	492.3	659.0
U.S.	16.3	20.5	18.6	19.9	20.5	21.1	24.9	27.4	36.2
U.S. %	6.8	5.6	5.1	5.7	5.5	5.3	5.7	5.6	5.5
ENDING STOCKS									
World	72.4	69.1	62.5	62.7	100.0	100.8	70.3	63.1	84.9
U.S.	36.7	9.2	11.7	18.1	30.2	31.8	19.4	18.0	15.3
U.S. %	50.7	13.3	18.7	28.9	30.2	31.5	27.6	28.5	18.0

WORLD OILSEEDS AND MEALS

(millions of metric tons, meal equivalent, calendar years)

	1972	1973	1974	1975	1976	1977	1978	1980	1985	2000
PRODUCTION										
World Total	55.9	57.6	68.3	64.1	72.9	66.7	78.0	72.1	87.3	97.3
U.S. Soybeans	27.4	33.3	26.2	33.3	27.2	34.3	37.9	36.2	45.4	53.1
U.S. %	49.0	57.8	38.4	52.0	37.3	51.4	48.6	50.2	52.0	54.6
TRADE										
World Total	25.6	25.6	27.3	27.2	33.2	32.2	34.9	36.2	48.4	60.9
U.S. Soybeans	13.1	14.9	15.9	13.7	17.0	16.4	18.6	18.1	24.1	31.0
U.S. %	51.2	58.2	58.2	50.4	51.2	50.9	53.3	50.0	49.8	50.9

APPENDIX D

SECTION III

ECONOMETRIC FORECASTING EQUATIONS: HARVESTED CORN, HARVESTED SOYBEANS HARVESTED WHEAT, SOYBEAN YIELD, WHEAT YIELD, AND CORN YIELD

ACREAGE HARVESTED EQUATIONS FOR CORN

(Table of Variable Coefficients)

State (ACCRN)	Independent Variables									$\bar{R}^2$	Dw	SE
	CONSTANT	ACW61	ACCRN1	PCRNH/F	CRNSOY	WTRCRN	RECRN1	OTHER 1	OTHER 2			
AR	0.01		0.89							0.922	2.07	0.09
	(0.03)		(17.60)									
IA*	9.31	-0.49		2.01		6.68				0.916	1.68	0.30
	(11.36)	(7.31)		(3.40)		(3.17)						
IL*	0.23	-0.42	0.83					5.06		0.895	1.41	0.27
	(0.16)	(4.82)	(8.64)					(2.73)				
IN*	1.85	-0.35		2.19	1.90					0.763	1.44	0.30
	(1.86)	(2.03)		(3.41)	(1.25)							
KS*	1.34	-0.57					0.14			0.785	1.20	0.11
	(3.12)	(2.45)					(1.33)					
KY*	0.57	-0.14	1.36			-3.36				0.778	1.81	0.05
	(5.08)	(3.13)	(5.48)			(3.05)						
LA	0.04		0.94							0.967	1.92	0.04
	(0.28)		(27.74)									
MN*	4.79	-0.51		0.77						0.789	1.62	0.28
	(6.77)	(5.51)		(1.49)								
MO	5.53	-0.33						-0.60	-0.47	0.640	1.64	0.20
	(11.46)	(3.52)						(1.80)	(5.27)			
MS	-0.23		0.95							0.976	2.13	0.09
	(0.71)		(32.66)									

* Variables for these states are of larger magnitude; see variable definitions.

Note: t-values for variables are in parentheses, below coefficient values.

State (ACCRN)	Independent Variables									$\bar{R}^2$	DW	SE
	CONSTANT	ACW61	ACCRN1	PCRNH/F	CRNSOY	WTRCRN	RECRN1	OTHER 1	OTHER 2			
ND	0.84 (2.12)	-0.87 (1.68)	0.72 (6.79)							0.794	1.94	0.06
NE*	1.05 (0.61)	-0.29 (1.58)	0.48 (3.30)					1.56 (1.88)		0.806	1.86	0.34
OH*	2.37 (8.97(	-0.72 (7.99)			2.38 (4.86)					0.847	2.23	0.14
OK	0.38 (4.55)	-2.16 (2.68)	0.62 (9.30)							0.867	2.14	0.12
PA*	0.60 (6.35)	-0.67 (6.18)		0.36 (5.22)		-3.48 (4.61)				0.927	1.80	0.04
SD*	4.03 (20.20)	-0.53 (5.20)						-1.37 (3.20)	-0.31 (4.29)	0.795	2.78	0.14
TN	0.34 (0.71)		0.93 (24.17)							0.957	1.95	0.10
WI*	0.74 (1.61)	-0.39 (2.33)		1.11 (3.35)						0.736	1.92	0.16
WV	0.05 (1.32)		0.89 (27.57)							0.967	2.31	0.98
AL	-0.35 (2.43)		0.80 (15.05)		1.10 (2.76)					0.973	1.50	0.09

* Variables for these states are of larger magnitude; see variable definitions.

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR CORN ACREAGE EQUATIONS

ACCRN = Acres of corn harvested in the given state (AR, IA, ... WV) in thousands of acres (millions of acres if footnoted)

ACW61 = Acres of corn withheld from production under various government programs, in thousands (millions if footnoted)

ACCRN1 = Previous years' harvested acreage of corn

PCRNH/F = Ratio of average fall/winter corn price to the spring price of fertilizer

CRNSOY = Ratio of average fall/winter corn price to average fall/winter soybean price

WTRCRN = Weighted index for exceptionally good or bad planting and harvesting conditions in the given state. Range ± 5

RECRN1 = Maximum of the loan rate, support price, target price, or previous year's season average market price for corn, in $/bu., lagged one year

OTHER 1:

IL — Ratio of season average prices of corn and soybeans, lagged one year

MO — Acreage of wheat withheld from production under various government programs, in thousands of acres

NE — Ratio of season average price of corn to spring price of fertilizer

SD — Acreage of soybeans, in millions of acres

OTHER 2:

MO — Sum of acreages of wheat and soybeans, in thousands of acres

SD — Maximum of the loan rate, support price, target price, or previous year's season average price, lagged one year

ACREAGE HARVESTED EQUATIONS FOR SOYBEANS

(Table of Variable Coefficients)

State (ACSOY)	Independent Variables									$\bar{R}^2$	DW	SE
	CONSTANT	SOYCRN1	ACSOY1	ACW61	SOYCOT1	DPC	WTRSOY	BTERM	SOYRCRN1			
AR	0.70 (3.37)		0.59 (6.83)		9.15 (4.09)					0.941	1.72	0.17
IA	-2.58 (3.34)	1.92 (4.48)	0.74 (11.58)	-0.09 (1.32)						0.948	2.87	0.33
IL	-1.68 (2.32)	1.66 (4.49)	0.74 (9.10)	-0.12 (1.08)						0.9333	2.32	0.30
IN	-0.69 (3.30)	0.87 (5.95)	0.64 (10.87)	-0.06 (1.12)						0.961	1.64	0.12
KS	0.40 (2.08)	0.35 (3.19)	0.56 (4.66)							0.806	2.62	0.12
KY	-0.36 (3.62)	0.20 (4.02)	0.94 (22.69)							0.976	0.97	0.06
LA	-0.09 (0.79)		0.98 (14.38)		2.30 (1.37)			-0.01 (1.65)		0.976	1.15	0.11
MN	-1.57 (2.29)	1.31 (4.37)	0.60 (5.13)			-0.74 (0.97)				0.800	1.87	0.29
MO	-0.98 (1.74)	0.79 (2.98)	0.80 (9.23)							0.888	2.69	0.24
MS	-0.20 (1.48)	0.82 (10.60)			6.86 (3.69)		-0.42 (2.72)			0.963	1.08	0.14

Note: t-values for variables are in parentheses, below coefficient values.

State (ACSOY)	Independent Variables									$\bar{R}^2$	DW	SE
	CONSTANT	SOYCRN1	ACSOY1	ACW61	SOYCOT1	DPC	WTRSOY	BTERM	SOYRCRN1			
ND	0.04 (2.14)		0.77 (7.08)							0.654	2.14	7.08
NE	-1.00 (3.54)		0.81 (9.21)				3.88 (1.41)		0.43 (4.09)	0.908	2.32	0.10
OH	-1.15 (4.02)	0.76 (5.58)	0.80 (15.25)							0.959	2.44	0.12
OK	-0.04 (1.12)	0.03 (1.72)	0.85 (10.16)							0.909	1.27	0.02
PA	-0.03 (3.71)	0.02 (4.15)	0.83 (11.67)							0.930	2.53	.004
SD	-0.21 (1.92)	0.13 (2.63)	0.70 (5.70)							0.744	1.60	0.05
TN	-0.21 (3.75)		0.81 (15.71)		4.53 (5.32)					0.984	1.68	0.07
WI	-0.07 (2.22)	0.07 (3.78)	0.55 (4.98)							0.765	1.92	0.02
WV	(no equation)											
AL	-0.21 (3.67)		0.85 (14.81)		3.40 (4.91)					0.977	2.31	0.06

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR SOYBEAN ACREAGE EQUATIONS

ACSOY	= Harvested acreage of soybeans in millions of acres in the given state (AR, IA, ... WI)
SOYCRN1	= Ratio of the previous year's season average price of soybeans and corn
ACSOY1	= The previous year's harvested acreage of soybeans (as above)
SOYCOT1	= Ratio of the previous year's season average prices of soybeans and cotton
DPC	= Effective diversion payment for corn in $/bu. under various government programs
WTRSOY	= Weighted index (range $\pm$ 5.0) for non-normal planting and harvesting conditions in the given state (AR, IA, ... WI)
BTERM	= A ratchet term to capture non-linear effect of large swings in price of cotton on soybean acreage: if the year-to-year change in the season average price of cotton exceeds 2¢ per pound, then the variable equals the change in cotton price; otherwise it equals 0.
SOYRCRN1	= Ratio of the previous year's season average price for soybeans to the maximum of the target price, support price, loan rate, of previous year's season average price for corn

ACREAGE HARVESTED EQUATIONS FOR WHEAT

(Table of Variable Coefficients)

State (ACWHT)	Independent Variables									$\bar{R}^2$	DW	SE
	CONSTANT	ACW62	ZPWHT1	REWHT1	ACWAL	ACSOY	ZPCOT1	WTRWHT	OTHER			
AR	265.46	-6.24							142.73	0.623	1.70	10.86
	(3.12)	(3.10)							(2.55)			
IA	135.23	-0.79	22.71			-0.02				0.813	2.32	11.50
	(6.47)	(1.94)	(6.21)			(6.16)						
IL*	2.43	-1.15	0.18			0.17				0.819	1.98	0.13
	(10.63)	(3.52)	(3.51)			(4.30)						
IN*	1.85	-0.67	0.24			-0.36				0.924	2.46	0.08
	(11.96)	(2.44)	(8.29)			(7.31)						
KS*	11.12	-0.58		0.23	-6.91			0.19		0.78	1.80	0.45
	(11.17)	(4.70)		(1.01)	(2.23)			(2.23)				
KY	126.48	-0.77		66.52	-3.39					0.91	2.75	22.5
	(2.96)	(2.72)		(6.49)	(2.48)							
LA	87.21	-6.03					-1.37		0.31	0.530	1.74	19.3
	(2.36)	(2.36)					(1.65)		(1.28)			
MN*	1.84	-1.50		0.34	-1.22				0.61	0.798	1.21	0.42
	(1.81)	(1.32)		(1.23)	(3.01)				(1.41)			
MO*	2.15	-1.15	0.14			-0.29				0.754	1.91	0.14
	(7.73)	(4.55)	(2.98)			(3.96)						
MS	290.75	-10.21					-3.14		0.18	0.619	2.04	64.4
	(2.98)	(3.19)					(1.42)		(0.85)			

* Variables for these states are of larger magnitude; see variable definitions.

Note: t-values for variables are in parentheses, below coefficient values.

State (ACWHT)	Independent Variables									$\bar{R}^2$	DW	SE
	CONSTANT	ACW62	ZPWHT1	REWHT1	ACWAL	ACSOY	ZPCOT1	WTRWHT	OTHER			
ND*	13.63	-0.58			-0.37					0.909	2.17	0.55
	(26.98)	(4.34)			(11.09)							
NE*	4.01	-0.71			-1.14				-0.12	0.816	2.34	0.11
	(8.69)	(7.84)			(2.09)				(1.16)			
OH*	1.42	-1.04		0.21		-0.19		0.07		0.894	2.52	0.10
	(10.24)	(3.51)		(3.30)		(2.12)		(1.92)				
OK*	6.24	-1.09		0.24	-9.24					0.894	2.25	0.31
	(9.08)	(6.93)		(1.53)	(4.32)							
PA	40.72	-0.59		37.50	18.88					0,936	1.73	24.8
	(0.80)	(3.96)		(3.14)	(11.77)							
SD*	2.89	-0.74		0.11	-3.79					0.926	1.36	0.12
	(9.69)	(6.62)		(1.70)	(3.76)							
TN	246.31	-1.49		27.76	-3.82					0.733	1.94	40.6
	(3.19)	(2.86)		(1.57)	(1.07)							
WI	65.08	-1.59	17.44			-0.239				0.922	1.06	6.16
	(5.67)	(3.72)	(8.57)			(4.58)						
WV	3.36	-0.65		1.71	7.5					0.809	1.71	1.80
	(0.99)	(3.13)		(2.10)	(6.80)							
AL	1.73				0.06					0.755	1.91	0.17
	(13.38)				(7.09)							

* Variables for these states are of larger magnitude; see variable definitions.

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR WHEAT ACREAGE EQUATIONS

ACWHT = Acres of wheat harvested in the given state (AR, IA, ... WV) in the thousands of acres (millions of acres if footnoted)

ACW62 = Acres of wheat withheld from production under various government programs, in thousands (millions if footnoted)

ZPWHT1 = Season average price of wheat, $/bu., lagged one year

REWHT1 = Maximum of season average price of wheat, loan rate for wheat, target price for wheat, or support price for wheat, in $/bu., lagged one year

ACWAL = Constructed variable for acreage allotmet for wheat

ACSOY = Acreage harvested of soybeans in the given state, in thousands (millions if footnoted)

ZPCOT1 = Season average price of cotton, ¢/lb., lagged one year

WTRWHT = Weighted index for exceptionally good or bad planting and harvesting conditions in the given state. Range ±5

OTHER:

MS, LA — Acreage of wheat lagged one year, in thousands of acres

AR — Average price of feed grain during fall (quarter 4) and following winter (quarter 1 of next year), index (1967=100)

NE — Ratio of wheat price ($/bu.) to corn price ($/bu.) during preceding fall quarter

MN — Ratio of wheat price ($/bu.) to corn price ($/bu.) during preceding winter quarter

YIELD EQUATIONS FOR SOYBEANS

(Table of Variable Coefficients)

State (YASOY)	CONSTANT	Independent Variables FERTSOY	SOYWTR	TREND	LOGTREND	$\bar{R}^2$	DW	SE
AR	10.16 (7.86)		1.50 (17.21)	0.16 (7.97)		.930	1.82	0.88
IA	26.93 (81.61)	11.94 (13.02)	.93 (13.25)			.951	1.87	0.67
IL	27.28 (53.58)	7.70 (6.68)	1.60 (12.25)			.926	1.64	0.92
IN	25.28 (45.71)	15.89 (8.57)	1.21 (16.58)			.953	2.23	0.67
KS	-7.22 (6.82)		1.63 (32.14)	0.40 (23.61)		.983	2.45	0.72
KY	23.14 (43.59)	26.69 (5.01)	0.65 (8.84)			.872	2.26	0.73
LA	21.80 (38.96)	32.60 (3.32)	0.71 (6.70)			.768	1.12	0.91
MN	19.83 (35.07)	14.65 (6.19)	0.94 (9.37)			.875	3.05	1.13
MO	23.23 (59.14)	8.22 (3.64)	1.07 (14.81)			.934	2.27	0.65
MS	5.41 (5.28)		1.64 (24.73)	0.23 (14.01)		.969	2.08	0.70

Note: t-values for variables are in parentheses, below coefficient values.

State (YASOY)	Independent Variables					$\bar{R}^2$	DW	SE
	CONSTANT	FERTSOY	SOYWTR	TREND	LOGTREND			
ND	15.55 (36.99)	16.22 (1.95)	1.28 (17.80)			.952	2.89	0.76
NE	11.55 (9.08)		2.34 (28.35)	0.20 (9.96)		0.972	1.72	0.86
OH	22.35 (44.98)	21.49 (9.54)	0.90 (14.79)			0.949	2.00	0.76
OK	15.47 (30.04)	0.08 (9.46)	0.93 (8.75)			0.895	2.11	0.91
PA	-96.38 (4.33)				28.75 (5.33)	0.594	1.46	3.12
SD	18.43 (55.97)	71.64 (6.68)	1.64 (18.25)			.959	1.81	0.75
TN	22.03 (22.43)	13.59 (1.20)	0.57 (3.93)			.467	1.68	1.09
WI	15.31 (30.20)	43.00 (12.75)	0.97 (10.03)			.933	1.99	0.87
WV	(no equation)							
AL	13.37 (4.82)		1.71 (4.29)	0.13 (3.05)		0.537	1.44	1.92

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR SOYBEAN YIELD EQUATIONS

YASOY = Yield per acre, in bushels of soybeans, in the given state (AR, IA, ... WI)

FERTSOY = Fertilizer variable constructed by multiplying the U.S. average application rate for N, K, and P on soybeans (in nutrient tons per acre) by the state's consumption of N, K, and P, in millions of nutrient tons

SOYWTR = Weighted index with range of ± 5 to account for exceptionally good or poor growing conditions for the soybean crop in a given state

TREND = Linear trend variable beginning with 49 and incrementing +1 per period (ie, 49, 50, 51, etc.)

LOGTREND = Natural logarithm of TREND variable, defined above

YIELD EQUATIONS FOR WHEAT

(Table of Variable Coefficients)

State (YAWHT)	Independent Variables						$\bar{R}^2$	DW	SE
	CONSTANT	FERTWHT	WHTWTR	ACW62	LOGTREND	TREND			
AR	29.71 (57.68)	12.05 (2.28)	1.50 (14.49)	25.00 (1.49)			0.932	3.01	0.96
IA	-140.8 (5.26)				40.78 (6.29)		0.588	2.37	4.49
IL	33.59 (84.99)	3.37 (4.61)	1.16 (17.43)	20.94 (12.83)			0.969	2.55	0.85
IN	33.50 (86.23)	7.62 (6.11)	1.33 (17.50)	27.74 (13.87)			0.973	1.78	0.79
KS	21.44 (53.05)	23.77 (15.32)	1.47 (17.21)	1.71 (8.76)			0.973	1.35	0.87
KY	27.90 (50.58)	34.72 (7.92)	1.20 (9.05)	60.69 (5.19)			0.909	2.41	1.00
LA	6.83 (3.73)		1.79 (23.13)			0.23 (8.54)	0.967	1.76	0.83
MN	24.12 (91.85)	18.75 (22.81)	1.10 (22.28)	5.21 (4.50)			0.986	2.43	0.57
MO	29.79 (68.55)	10.77 (6.28)	1.32 (14.40)	3.74 (3.53)			0.947	2.19	0.81
MS	13.36 (12.40)		1.69 (25.99)			0.21 (12.36)	0.970	2.41	0.73

Note: t-values for variables are in parentheses, below coefficient values.

State	Independent Variables								
(YAWHT)	CONSTANT	FERTWHT	WHTWTR	ACW62	LOGTREND	TREND	$\bar{R}^2$	DW	SE
ND	20.75 (49.00)	31.58 (6.03)	1.74 (14.65)	2.17 (9.93)			0.958	2.47	0.95
NE	22.49 (56.08)	33.58 (21.10)	1.49 (17.51)	4.90 (7.30)			0.982	2.60	0.88
OH	-163.1 (7.60)				47.4 (9.12)		0.752	2.46	3.60
OK	22.44 (75.13)	11.28 (3.67)	1.23 (18.69)				0.958	2.11	0.71
PA	30.16 (73.07)	26.43 (5.39)	1.10 (11.72)	11.90 (2.86)			0.92	2.71	0.80
SD	16.90 (35.97)	64.20 (7.34)	1.81 (17.63)	4.23 (6.14)			0.961	1.79	1.04
TN	24.81 (63.08)	60.88 (17.29)	0.81 (14.42)	20.04 (3.20)			0.972	2.58	0.65
WI	1.16 (0.97)		1.36 (20.29)			0.48 (25.34)	0.974	2.14	0.81
WV	25.97 (50.70)	69.49 (11.60)	1.16 (8.47)	196.67 (1.94)			0.94	1.56	0.96
AL	3.99 (1.12)		1.25 (2.44)			0.31 (5.51)	0.518	1.27	2.48

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR WHEAT YIELD EQUATIONS

YAWHT = Yield per acre, in bushels of wheat, in a given state (AR, IA, ... WV)

FERTWHT = Fertilizer variable constructed by multiplying the U.S. average application rate for N, K, and P on wheat (in nutrient tons per acre) by the state's consumption of N, K, and P, in millions of nutrient tons

WHTWTR = Weighted index with range of ±5 to account for exceptionally good or poor growing conditions for wheat in a given state

ACW62 = Acres of wheat withheld from production in the given state under various government programs

TREND = Linear trend variable where 1949=49 . . . 2000=100

LOGTREND = Natural logarithm of TREND variable

YIELD EQUATIONS FOR CORN

(Table of Variable Coefficients)

State (YACRN)	CONSTANT	Independent Variables FERTCRN	CRNWTR	ACW61	LOGTREND	$\bar{R}^2$	DW	SE
AR	28.09 (13.75)	54.62 (5.08)	2.16 (6.04)			0.839	2.36	2.94
IA	60.43 (22.43)	19.88 (10.82)	3.51 (7.52)	4.18 (6.36)		0.914	2.69	3.77
IL	76.15 (43.66)	16.45 (10.62)	4.71 (12.75)			0.945	2.26	3.28
IN	67.78 (26.84)	32.14 (8.33)	4.63 (11.39)			0.927	1.66	3.56
KS	-694.97 (11.11)				181.51 (11.98)	0.841	0.95	10.48
KY	-506.21 (10.38)				136.69 (11.57)	0.831	2.13	8.17
LA	22.57 (7.95)	12.72 (7.66)	2.54 (4.54)			0.835	2.07	4.53
MN	47.46 (18.27)	23.88 (8.15)	4.19 (8.18)	9.62 (9.14)		0.917	2.10	3.72
MO	47.72 (21.86)	34.66 (10.69)	4.23 (17.64)	5.67 (6.41)		0.964	2.55	2.40
MS	28.54 (8.88)	41.59 (3.09)	2.28 (2.50)			0.435	2.20	4.39

Note: t-values for variables are in parentheses, below coefficient values.

State (YACRN)	CONSTANT	Independent Variables FERTCRN	CRNWTR	ACW61	LOGTREND	$\bar{R}^2$	DW	SE
ND	20.70 (9.93)	10.40 (8.72)	3.64 (7.91)	14.40 (3.81)		0.886	2.15	3.79
NE	44.11 (28.85)	48.02 (24.20)	2.37 (16.60)	5.59 (9.22)		0.982	2.20	2.10
OH	59.47 (18.90)	40.82 (8.77)	2.90 (6.21)	6.73 (3.03)		0.870	2.21	3.43
OK	-1298.3 (7.72)				321.34 (8.06)	0.800	0.96	11.89
PA	49.30 (11.70)	15.28 (7.26)	4.37 (8.65)	-16.27 (1.81)		0.902	1.23	3.73
SD	30.69 (15.34)	39.89 (2.95)	2.42 (7.65)	10.47 (6.47)		0.871	2.26	3.26
TN	27.61 (9.89)	13.73 (10.03)	2.98 (7.75)			0.910	2.33	3.16
WI	54.68 (19.24)	54.78 (8.07)	3.49 (8.52)	20.42 (7.34)		0.900	1.50	3.41
WV	-365.74 (8.93)				102.2 (10.31)	0.796	1.02	6.86
AL	-247.06 (17.98)		4.18 (15.13)		67.72 (20.39)	0.961	2.16	2.40

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR CORN YIELD EQUATIONS

YACRN = Yield per acre, in bushels of corn, in a given state (AR, IA, ... WV)

FERTCRN = Fertilizer variable constructed by multiplying the U.S. average application rate for N, K, and P on corn (in nutrient tons per acre) by the state's consumption of N, K, and P, in millions of nutrient tons

CRNWTR = Weighted index with range of ±5 to account for exceptionally good or poor growing conditions for corn in a given state

ACW61 = Acres of corn withheld from production in the given state under various government programs

LOGTREND = Natural logarithm of the variable TREND, which in 1949=49 and increases by one each year (ie, 49, 50, 51, ... 100)

MID-AMERICA PORTS STUDY

FERTILIZER CONSUMPTION

$$AQDSUM^{**}_t = (AQDNX_t/AQDNX_{t-1})\ AQDN^{**}_{t-1} + (AQDKX_t/AQDKX_{t-1})\ AQDK^{**}_{t-1} + (AQDPX_t/AQDPX_{t-1})\ AQDP^{**}_{t-1}$$

where:

AQDSUM** = Sum of consumption in nutrient tons of N, K, and P, in millions of tons for a given state.

AQDNX = Index for total U.S. consumption of N

AQDKX = Index for total U.S. consumption of K

AQDPX = Index for total U.S. consumption of P

AQDN** = Consumption in nutrient tons, of N, millions of tons. Initialized as the mean for 1974-1976.

AQDK** = As AQDN**, for K

AQDP** = As AQDN**, for P

** In each variable, ** refers to state labels, such as "AL" for Alabama, etc.

APPENDIX D

SECTION IV

FORECAST HARVESTED ACREAGE, YIELD AND PRODUCTION FOR CORN, SOYBEANS, AND WHEAT, BY STATE TO YEAR 2000

CORN HARVESTED ACREAGE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ILLINOIS	11.69	11.02	11.24	10.36	11.06	11.09	11.13	11.16	11.20	11.23	11.41	11.58	11.75
INDIANA	6.30	6.20	5.91	5.40	5.66	5.83	5.88	5.95	5.97	6.17	6.54	6.61	6.68
IOWA	12.75	12.50	11.34	10.66	11.46	11.32	11.26	11.20	11.16	11.32	11.59	11.64	11.68
MINNESOTA	5.60	5.90	5.57	5.25	5.91	5.86	5.84	5.81	5.80	5.86	5.97	5.98	6.00
NEBRASKA	6.20	6.35	5.78	5.32	5.64	5.58	5.58	5.60	5.65	5.73	5.79	5.80	5.81
OHIO	3.92	3.75	3.25	3.04	3.68	3.56	3.50	3.47	3.43	3.47	3.57	3.59	3.62
SUBTOTAL	46.46	45.72	43.08	39.74	43.41	43.24	43.18	43.19	43.21	43.80	44.87	45.20	45.54
ALABAMA	0.80	0.72	0.63	0.62	0.61	0.55	0.51	0.48	0.45	0.42	0.37	0.38	0.40
ARKANSAS	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
KANSAS	1.79	1.65	1.62	1.52	1.66	1.68	1.71	1.74	1.77	1.80	1.88	1.98	2.10
KENTUCKY	1.36	1.42	1.07	1.12	1.15	1.08	1.05	1.03	1.01	1.03	1.08	1.10	1.12
LOUISIANA	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.01
MISSISSIPPI	0.17	0.18	0.15	0.12	0.09	0.06	0.04	0.01	0.01	0.01	0.01	0.01	0.01
MISSOURI	2.85	2.79	2.71	2.57	2.84	2.82	2.70	2.66	2.61	2.57	2.46	2.42	2.40
NORTH DAKOTA	0.18	0.19	0.22	0.24	0.26	0.27	0.28	0.29	0.29	0.29	0.30	0.30	0.30
OKLAHOMA	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
PENNSYLVANIA	1.15	1.17	0.97	0.89	0.99	0.97	0.95	0.94	0.94	0.97	1.02	1.02	1.03
SOUTH DAKOTA	1.20	2.00	2.65	2.51	2.62	2.58	2.51	2.47	2.37	2.31	1.99	1.76	1.48
TENNESSEE	0.72	0.75	0.73	0.71	0.69	0.67	0.66	0.64	0.63	0.62	0.57	0.53	0.51
WEST VIRGINIA	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
WISCONSIN	2.18	2.40	1.86	1.79	1.93	1.86	1.82	1.78	1.77	1.85	2.00	2.03	2.05
TOTAL	59.14	59.16	55.31	51.46	55.87	55.45	55.11	54.96	54.80	55.43	56.33	56.51	56.70

CORN YIELD IN BUSHELS PER ACRE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	62.0	27.0	48.0	48.8	49.7	50.5	51.3	52.2	53.0	53.8	57.7	61.3	64.8
ARKANSAS	56.0	46.0	46.7	47.8	48.8	50.0	51.1	52.2	53.3	54.4	59.9	65.0	69.7
ILLINOIS	107.0	110.0	110.9	113.0	114.7	116.4	118.1	119.8	121.5	123.3	131.8	140.4	148.9
INDIANA	110.0	102.0	102.5	104.5	106.3	108.5	110.4	112.4	114.5	116.6	126.6	135.9	144.3
IOWA	90.0	99.0	99.9	108.6	104.5	107.1	109.3	111.6	114.0	116.5	128.1	139.0	149.0
KANSAS	95.0	94.0	95.8	98.1	99.9	101.6	103.4	105.1	106.9	108.6	117.4	126.2	135.0
KENTUCKY	102.0	88.0	89.3	91.1	92.8	94.5	96.2	97.8	99.4	101.1	108.9	116.3	123.3
LOUISIANA	68.0	59.0	60.2	62.5	64.2	65.9	67.5	69.2	70.9	72.6	80.9	89.3	97.7
MINNESOTA	59.0	76.0	76.6	84.6	79.9	81.8	83.4	85.1	86.8	88.6	97.1	105.1	112.3
MISSISSIPPI	47.0	45.0	45.7	46.8	47.8	48.9	49.9	50.9	52.0	53.0	58.2	63.0	67.4
MISSOURI	61.0	74.0	75.0	78.6	78.3	80.2	81.9	83.6	85.3	87.2	95.7	103.8	111.1
NEBRASKA	83.0	91.0	91.9	99.0	101.0	103.0	105.0	107.0	109.0	111.1	121.1	131.2	141.2
NORTH DAKOTA	40.0	60.0	60.2	62.6	64.2	65.8	67.4	69.0	70.6	72.2	80.2	88.2	96.2
OHIO	101.0	97.0	97.4	102.7	101.6	103.9	106.0	108.2	110.4	112.8	123.7	133.8	143.0
OKLAHOMA	95.0	98.0	98.5	100.0	101.4	102.8	104.1	105.3	106.6	107.7	112.9	117.2	120.5
PENNSYLVANIA	90.0	89.0	90.2	90.4	91.9	93.4	94.9	96.4	97.9	99.5	107.0	114.6	122.1
SOUTH DAKOTA	31.0	39.0	38.9	40.8	41.7	42.6	43.6	44.5	45.4	46.3	50.9	55.5	60.1
TENNESSEE	79.0	70.0	71.4	73.9	76.2	78.8	81.3	83.8	86.4	89.0	101.6	113.3	123.9
WEST VIRGINIA	88.0	78.0	79.5	80.8	82.1	83.4	84.7	85.9	87.1	88.3	94.2	99.7	104.9
WISCONSIN	68.0	85.0	85.6	92.6	89.0	90.8	92.5	94.3	96.1	97.9	106.7	114.7	122.0
TOTAL	88.7	92.1	93.7	98.5	98.0	100.0	102.1	104.0	106.1	108.2	118.2	127.7	136.8

CORN PRODUCTION IN MILLIONS OF BUSHELS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	49.4	19.3	30.4	30.1	30.1	27.7	26.3	24.9	23.7	22.7	21.4	23.1	26.0
ARKANSAS	2.5	2.0	1.8	1.6	1.4	1.3	1.1	1.0	0.8	0.7	0.6	0.6	0.6
ILLINOIS	1250.8	1212.2	1246.5	1136.9	1268.7	1291.6	1314.7	1337.8	1361.1	1384.5	1503.2	1624.9	1749.6
INDIANA	693.0	632.4	605.9	564.4	601.6	632.2	648.9	668.8	683.1	719.8	828.3	898.4	964.4
IOWA	1147.5	1237.5	1132.8	1157.8	1197.1	1212.4	1230.6	1250.0	1272.6	1318.9	1485.0	1617.8	1739.6
KANSAS	170.1	155.1	155.2	149.6	165.4	171.2	176.8	182.7	189.3	195.1	220.2	249.4	282.9
KENTUCKY	138.7	125.0	95.6	101.8	106.7	101.8	100.7	100.4	100.0	104.0	117.9	127.7	137.5
LOUISIANA	5.9	4.7	4.3	3.9	3.6	3.2	2.8	2.4	2.1	1.7	0.5	0.6	0.6
MINNESOTA	330.4	448.4	426.6	444.8	472.7	479.4	486.9	494.9	503.8	519.8	579.6	628.8	673.9
MISSISSIPPI	8.1	8.1	6.8	5.5	4.3	3.1	1.8	0.6	0.4	0.4	0.4	0.5	0.5
MISSOURI	173.9	199.8	203.1	202.1	222.8	226.0	221.2	222.5	222.6	224.1	235.2	251.5	266.8
NEBRASKA	514.6	577.9	530.8	527.0	569.6	574.4	585.8	599.8	616.1	636.4	701.6	760.9	820.4
NORTH DAKOTA	7.2	11.4	13.3	15.2	16.6	17.8	18.9	19.8	20.5	21.2	24.1	26.7	29.1
OHIO	395.9	363.8	316.3	312.3	374.3	369.6	371.6	375.4	379.1	391.6	441.1	480.9	518.1
OKLAHOMA	8.6	8.3	8.9	9.2	9.6	9.9	10.1	10.3	10.5	10.7	11.2	11.6	12.0
PENNSYLVANIA	103.5	103.7	87.4	80.3	91.0	90.3	90.6	91.0	91.9	96.2	108.7	117.2	125.9
SOUTH DAKOTA	37.2	78.0	102.9	102.4	109.1	109.9	109.4	109.8	107.6	107.1	101.3	97.5	89.2
TENNESSEE	56.5	52.5	52.0	52.4	52.6	53.1	53.5	53.9	54.4	55.0	57.6	60.4	63.1
WEST VIRGINIA	5.4	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.7	4.8
WISCONSIN	148.2	204.0	159.3	165.9	171.5	168.5	168.1	168.2	169.7	181.6	213.8	232.5	250.3
TOTAL	5247.4	5448.6	5184.6	5067.6	5473.3	5547.9	5624.3	5718.5	5813.7	5995.9	6656.1	7215.7	7755.4

CORN PRODUCTION IN MILLIONS OF SHORT TONS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	1.38	0.54	0.85	0.84	0.84	0.78	0.74	0.70	0.66	0.64	0.60	0.65	0.73
ARKANSAS	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02
ILLINOIS	35.02	33.94	34.90	31.83	35.52	36.17	36.81	37.46	38.11	38.77	42.09	45.50	48.99
INDIANA	19.40	17.71	16.97	15.80	16.84	17.70	18.17	18.73	19.13	20.16	23.19	25.16	27.00
IOWA	32.13	34.65	31.72	32.42	33.52	33.95	34.46	35.00	35.63	36.93	41.58	45.30	48.71
KANSAS	4.76	4.34	4.35	4.19	4.63	4.79	4.95	5.11	5.30	5.46	6.17	6.98	7.92
KENTUCKY	3.88	3.50	2.68	2.85	2.99	2.85	2.82	2.81	2.80	2.91	3.30	3.58	3.85
LOUISIANA	0.17	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.01	0.02	0.02
MINNESOTA	9.25	12.56	11.94	12.45	13.23	13.42	13.63	13.86	14.11	14.55	16.23	17.61	18.87
MISSISSIPPI	0.23	0.23	0.19	0.15	0.12	0.09	0.05	0.02	0.01	0.01	0.01	0.01	0.01
MISSOURI	4.87	5.59	5.69	5.66	6.24	6.33	6.19	6.23	6.23	6.27	6.58	7.04	7.47
NEBRASKA	14.41	16.18	14.86	14.75	15.95	16.08	16.40	16.79	17.25	17.82	19.64	21.31	22.97
NORTH DAKOTA	0.20	0.32	0.37	0.42	0.47	0.50	0.53	0.55	0.57	0.59	0.68	0.75	0.82
OHIO	11.09	10.19	8.86	8.74	10.48	10.35	10.41	10.51	10.61	10.97	12.35	13.47	14.51
OKLAHOMA	0.24	0.23	0.25	0.26	0.27	0.28	0.28	0.29	0.29	0.30	0.31	0.33	0.34
PENNSYLVANIA	2.90	2.90	2.45	2.25	2.55	2.53	2.54	2.55	2.57	2.69	3.04	3.28	3.52
SOUTH DAKOTA	1.04	2.18	2.88	2.87	3.06	3.08	3.06	3.07	3.01	3.00	2.84	2.73	2.50
TENNESSEE	1.58	1.47	1.46	1.47	1.47	1.49	1.50	1.51	1.52	1.54	1.61	1.69	1.77
WEST VIRGINIA	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.13	0.13	0.13	0.14
WISCONSIN	4.15	5.71	4.46	4.64	4.80	4.72	4.71	4.71	4.75	5.09	5.99	6.51	7.01
TOTAL	146.93	152.56	145.17	141.89	153.25	155.34	157.48	160.12	162.78	167.89	186.37	202.04	217.15

SOYBEAN HARVESTED ACREAGE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ARKANSAS	4.32	4.60	4.38	4.39	3.92	3.91	4.18	4.26	4.34	4.45	4.48	4.46	4.45
ILLINOIS	7.56	8.80	9.21	9.24	8.33	8.56	9.19	9.43	9.62	9.78	9.96	9.79	9.56
INDIANA	3.28	3.87	4.07	4.07	3.63	3.79	4.08	4.17	4.23	4.28	4.29	4.20	4.10
IOWA	6.59	7.20	7.89	8.04	7.31	7.69	8.36	8.66	8.91	9.11	9.37	9.19	8.91
MINNESOTA	3.02	3.81	4.20	4.04	3.64	3.95	4.32	4.45	4.54	4.61	4.59	4.47	4.33
MISSISSIPPI	3.25	3.90	3.72	3.70	3.27	3.15	3.27	3.31	3.36	3.44	3.57	3.59	3.59
MISSOURI	4.20	4.75	4.91	5.01	4.49	4.54	4.83	4.94	5.04	5.12	5.26	5.19	5.06
OHIO	2.88	3.38	3.57	3.64	3.27	3.36	3.60	3.71	3.81	3.89	4.03	3.97	3.84
SUBTOTAL	35.10	40.31	41.95	42.12	37.87	38.95	41.83	42.93	43.84	44.67	45.54	44.87	43.86
ALABAMA	1.22	1.68	1.57	1.47	1.40	1.36	1.33	1.33	1.34	1.36	1.39	1.39	1.39
KANSAS	0.87	0.96	1.07	1.08	0.96	1.03	1.12	1.15	1.17	1.18	1.17	1.14	1.11
KENTUCKY	1.07	1.36	1.46	1.55	1.55	1.56	1.56	1.57	1.57	1.58	1.60	1.63	1.65
LOUISIANA	NA	2.12	2.67	2.74	2.75	2.77	2.78	2.80	2.81	2.83	2.90	2.98	3.05
NEBRASKA	1.03	1.26	1.48	1.61	1.51	1.63	1.80	1.91	1.99	2.07	2.24	2.23	2.17
NORTH DAKOTA	0.15	0.21	0.20	0.20	0.18	0.17	0.18	0.18	0.18	0.18	0.17	0.17	0.17
OKLAHOMA	0.24	0.27	0.27	0.28	0.25	0.25	0.27	0.27	0.28	0.28	0.29	0.29	0.29
PENNSYLVANIA	0.04	0.05	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07
SOUTH DAKOTA	0.27	0.31	0.35	0.37	0.33	0.36	0.39	0.41	0.42	0.43	0.44	0.43	0.41
TENNESSEE	1.80	2.16	2.02	1.97	1.72	1.64	1.69	1.71	1.74	1.79	1.85	1.86	1.86
WISCONSIN	0.15	0.19	0.21	0.20	0.18	0.19	0.21	0.21	0.22	0.22	0.22	0.21	0.21
TOTAL	44.06	51.29	51.75	52.18	47.36	48.61	51.91	53.21	54.29	55.30	56.51	55.88	54.84

SOYBEAN YIELD IN BUSHELS PER ACRE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	24.0	19.0	23.7	23.9	24.3	24.7	25.1	25.5	25.9	26.4	28.4	30.5	32.5
ARKANSAS	18.0	23.0	22.9	23.1	23.4	23.7	23.9	24.2	24.5	24.8	26.2	27.6	29.0
ILLINOIS	32.0	33.0	33.6	34.1	34.2	34.5	34.9	35.3	35.8	36.3	38.3	40.1	41.7
INDIANA	33.0	32.0	32.7	33.3	33.5	33.7	34.2	34.7	35.3	35.8	38.2	40.2	42.0
IOWA	31.0	35.0	35.3	36.0	36.2	36.5	37.1	37.7	38.4	39.0	41.8	44.2	46.5
KANSAS	15.0	23.0	23.7	24.1	24.5	24.9	25.3	25.7	26.1	26.5	28.5	30.5	32.4
KENTUCKY	26.5	28.0	27.9	28.2	28.6	29.0	29.4	29.8	30.2	30.7	32.7	34.8	36.8
LOUISIANA	26.0	25.0	25.1	25.4	25.8	26.2	26.6	27.0	27.4	27.7	29.7	31.6	33.6
MINNESOTA	21.0	26.0	26.8	27.3	27.5	27.7	28.2	28.7	29.2	29.7	32.0	33.9	35.7
MISSISSIPPI	22.0	23.0	23.2	23.4	23.7	23.9	24.1	24.3	24.6	24.8	25.9	27.1	28.2
MISSOURI	29.0	26.0	25.8	26.0	26.4	26.8	27.2	27.5	27.9	28.3	30.2	32.2	34.1
NEBRASKA	20.0	27.0	27.2	27.4	28.0	28.6	29.2	29.7	30.3	30.9	33.8	36.8	39.7
NORTH DAKOTA	12.5	17.0	17.1	17.3	17.7	18.1	18.5	18.9	19.3	19.7	21.6	23.6	25.6
OHIO	32.5	31.0	31.1	31.8	32.0	32.3	32.9	33.5	34.1	34.8	37.5	39.8	42.0
OKLAHOMA	22.0	24.0	24.0	24.8	25.1	25.4	25.7	26.0	26.3	26.7	28.2	29.8	31.3
PENNSYLVANIA	29.0	28.0	28.9	29.2	29.6	30.0	30.3	30.7	31.0	31.3	33.0	34.5	36.0
SOUTH DAKOTA	17.0	22.0	22.6	23.0	23.1	23.2	23.5	23.8	24.2	24.6	26.1	27.4	28.6
TENNESSEE	22.5	24.0	23.9	24.0	24.3	24.6	24.9	25.2	25.5	25.8	27.2	28.7	30.2
WEST VIRGINIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WISCONSIN	22.0	27.0	27.7	28.6	29.0	29.4	30.2	31.0	31.9	32.7	33.4	34.0	34.6
TOTAL	26.1	28.3	29.8	30.2	30.5	30.9	31.3	31.8	32.3	32.8	34.9	36.9	38.8

SOYBEAN PRODUCTION IN MILLIONS OF BUSHELS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	29.3	31.8	37.2	35.2	34.0	33.6	33.5	33.9	34.7	36.0	39.6	42.4	45.0
ARKANSAS	77.8	105.8	100.2	101.5	91.7	92.6	100.1	103.3	106.4	110.2	117.2	123.2	129.2
ILLINOIS	241.9	290.4	309.4	314.8	285.3	295.0	320.6	333.1	344.3	354.7	381.6	392.4	398.6
INDIANA	108.2	123.8	133.3	135.5	121.7	127.7	139.6	144.8	149.3	153.5	163.6	168.7	172.5
IOWA	204.3	252.0	278.7	289.4	265.0	280.6	310.1	326.7	341.6	355.6	392.1	406.7	414.6
KANSAS	13.0	22.1	25.5	26.1	23.4	25.7	28.4	29.6	30.5	31.3	33.4	34.7	35.9
KENTUCKY	28.4	38.1	40.7	43.7	44.5	45.3	46.0	46.8	47.6	48.4	52.4	56.5	60.7
LOUISIANA	55.1	63.8	67.0	69.6	71.0	72.5	74.0	75.5	77.0	78.5	86.2	94.2	102.5
MINNESOTA	63.4	99.1	112.5	110.2	100.1	109.4	121.8	127.7	132.6	137.0	146.9	151.5	154.9
MISSISSIPPI	71.5	89.7	86.3	86.6	77.5	75.4	78.8	80.5	82.5	85.3	92.5	97.2	101.2
MISSOURI	84.0	123.5	126.7	130.1	118.5	121.7	131.2	136.1	140.6	144.9	159.0	167.1	172.7
NEBRASKA	20.6	34.0	40.4	44.0	42.2	46.4	52.6	56.7	60.5	64.0	75.7	82.2	86.2
NORTH DAKOTA	1.8	3.6	3.4	3.5	3.2	3.1	3.3	3.4	3.4	3.5	3.8	4.1	4.5
OHIO	93.6	104.8	111.1	115.6	104.7	108.5	118.4	124.3	129.8	135.1	150.9	158.0	161.5
OKLAHOMA	5.3	6.4	6.5	6.9	6.4	6.4	6.9	7.1	7.3	7.5	8.3	8.7	9.0
PENNSYLVANIA	1.2	1.4	1.6	1.7	1.5	1.6	1.8	1.9	2.0	2.1	2.4	2.5	2.5
SOUTH DAKOTA	4.6	6.7	8.0	8.4	7.6	8.3	9.2	9.8	10.2	10.6	11.5	11.7	11.7
TENNESSEE	40.5	51.8	48.3	47.3	41.8	40.4	42.2	43.1	44.3	46.1	50.5	53.5	56.1
WEST VIRGINIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WISCONSIN	3.3	5.1	5.7	5.8	5.2	5.7	6.3	6.6	6.9	7.2	7.3	7.2	7.1
TOTAL	1147.8	1453.8	1542.5	1576.0	1445.4	1500.0	1624.7	1690.7	1751.6	1811.6	1974.8	2062.4	2126.4

SOYBEAN PRODUCTION IN MILLIONS OF SHORT TONS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	0.88	0.95	1.12	1.06	1.02	1.01	1.00	1.02	1.04	1.08	1.19	1.27	1.35
ARKANSAS	2.33	3.17	3.01	3.04	2.75	2.79	3.00	3.10	3.19	3.31	3.52	3.70	3.88
ILLINOIS	7.26	8.71	9.28	9.44	9.56	8.85	9.62	9.99	10.33	10.64	11.45	11.77	11.96
INDIANA	3.25	3.72	4.00	4.07	3.65	3.83	4.19	4.34	4.48	4.60	4.91	5.06	5.18
IOWA	6.13	7.56	8.36	8.59	7.95	8.42	9.30	9.80	10.25	10.67	11.76	12.20	12.44
KANSAS	0.59	0.66	0.76	0.78	0.70	0.77	0.85	0.89	0.91	0.94	1.00	1.04	1.08
KENTUCKY	0.85	1.14	1.22	1.31	1.33	1.36	1.38	1.40	1.43	1.45	1.57	1.70	1.82
LOUISIANA	1.65	1.91	2.01	2.09	2.13	2.18	2.22	2.26	2.31	2.35	2.59	2.83	3.07
MINNESOTA	1.90	2.97	3.38	3.31	3.00	3.28	3.65	3.83	3.98	4.11	4.41	4.55	4.65
MISSISSIPPI	2.15	2.69	2.59	2.60	2.32	2.26	2.36	2.41	2.47	2.56	2.78	2.92	3.04
MISSOURI	2.52	3.71	3.80	3.90	3.56	3.65	3.94	4.08	4.22	4.35	4.77	5.01	5.18
NEBRASKA	0.62	1.02	1.21	1.32	1.27	1.39	1.58	1.70	1.82	1.92	2.27	2.47	2.59
NORTH DAKOTA	0.06	0.11	0.10	0.11	0.10	0.09	0.10	0.10	0.10	0.10	0.11	0.12	0.13
OHIO	2.81	3.14	3.33	3.47	3.14	3.25	3.55	3.73	3.89	4.05	4.53	4.74	4.84
OKLAHOMA	0.16	0.19	0.20	0.21	0.19	0.19	0.21	0.21	0.22	0.23	0.25	0.26	0.27
PENNSYLVANIA	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
SOUTH DAKOTA	0.14	0.20	0.24	0.25	0.23	0.25	0.28	0.29	0.31	0.32	0.35	0.35	0.35
TENNESSEE	1.22	1.56	1.45	1.42	1.25	1.21	1.26	1.29	1.33	1.38	1.52	1.60	1.68
WEST VIRGINIA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WISCONSIN	0.10	0.15	0.17	0.18	0.16	0.17	0.19	0.20	0.21	0.22	0.22	0.22	0.21
TOTAL	34.44	43.62	46.27	47.28	43.36	45.00	48.74	50.72	52.55	54.35	59.24	61.87	63.79

WHEAT HARVESTED ACREAGE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
KANSAS	11.30	12.30	10.00	11.42	11.44	11.44	11.46	11.48	11.50	11.49	11.51	11.49	11.51
MINNESOTA	4.06	3.31	1.61	3.07	3.09	3.17	3.30	3.33	3.45	3.34	3.36	3.28	3.26
NEBRASKA	2.95	3.05	2.53	2.96	2.95	2.93	2.91	2.90	2.88	2.88	2.85	2.79	2.73
NORTH DAKOTA	11.66	9.63	8.57	9.67	10.53	10.90	11.27	11.66	11.69	11.71	11.85	11.99	12.13
OKLAHOMA	6.30	6.50	4.99	6.52	6.58	6.63	6.69	6.76	6.77	6.76	6.79	6.77	6.78
SOUTH DAKOTA	2.99	3.01	2.56	3.08	3.12	3.16	3.21	3.25	3.28	3.30	3.41	3.50	3.61
SUBTOTAL	39.25	37.80	30.26	36.71	37.72	38.24	38.83	39.37	39.57	39.49	39.77	39.82	40.01
ALABAMA	0.13	0.12	0.14	0.15	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17
ARKANSAS	0.71	0.70	0.51	0.49	0.48	0.47	0.47	0.47	0.47	0.48	0.48	0.49	0.53
ILLINOIS	1.65	1.60	0.91	1.31	1.46	1.42	1.35	1.30	1.30	1.28	1.32	1.39	1.49
INDIANA	1.60	1.27	0.70	0.97	1.13	1.08	1.03	0.99	1.02	1.02	1.15	1.28	1.44
IOWA	0.09	0.07	0.03	0.03	0.05	0.04	0.04	0.03	0.04	0.04	0.05	0.07	0.10
KENTUCKY	0.33	0.27	0.25	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.29	0.29	0.30
LOUISIANA	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.03	0.01	0.01	0.01	0.01	0.01
MISSISSIPPI	0.18	0.13	0.16	0.17	0.17	0.15	0.14	0.13	0.12	0.11	0.09	0.07	0.05
MISSOURI	1.65	1.55	0.67	1.08	1.24	1.25	1.21	1.18	1.20	1.20	1.30	1.44	1.61
OHIO	1.65	1.54	0.97	1.33	1.39	1.35	1.29	1.26	1.28	1.27	1.35	1.43	1.54
PENNSYLVANIA	0.32	0.26	0.20	0.23	0.21	0.20	0.18	0.16	0.17	0.18	0.21	0.25	0.28
TENNESSEE	0.34	0.28	0.20	0.32	0.32	0.33	0.33	0.34	0.34	0.35	0.38	0.40	0.42
WEST VIRGINIA	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
WISCONSIN	0.09	0.08	0.03	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.11	0.13
TOTAL	48.22	45.79	34.93	43.04	44.56	44.91	45.24	45.62	45.90	45.78	46.52	47.06	47.94

WHEAT YIELD IN BUSHELS PER ACRE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	27.0	26.0	28.1	28.4	28.8	29.1	29.4	29.7	30.0	30.3	31.8	33.4	34.9
ARKANSAS	30.0	31.0	31.5	31.6	31.8	32.0	32.2	32.4	32.5	32.8	33.7	34.4	35.1
ILLINCIS	39.0	37.0	40.1	36.9	37.7	38.5	39.2	40.0	40.8	41.6	45.4	49.3	53.2
INDIANA	36.0	37.0	42.6	37.9	38.7	39.5	40.3	41.2	42.0	42.8	47.0	51.1	55.2
IOWA	35.0	36.0	36.8	37.4	37.9	38.4	38.9	39.4	39.9	40.3	42.7	44.9	47.0
KANSAS	30.0	32.0	34.6	32.7	33.4	34.2	34.9	35.6	36.3	37.1	40.7	44.4	48.0
KENTUCKY	31.0	34.0	37.1	34.7	35.0	35.2	35.5	35.8	36.0	36.3	37.6	39.0	40.3
LOUISIANA	33.0	25.0	25.4	25.7	25.9	26.1	26.4	26.6	26.8	27.1	28.3	29.5	30.7
MINNESOTA	32.2	34.0	36.8	34.9	35.5	36.1	36.7	37.3	37.9	38.6	41.6	44.7	47.7
MISSISSIPPI	29.0	30.0	29.8	30.0	30.2	30.5	30.7	30.9	31.1	31.3	32.4	33.4	34.5
MISSOURI	33.0	34.0	35.1	34.1	34.7	35.2	35.8	36.4	36.9	37.5	40.3	43.2	46.0
NEBRASKA	32.0	35.0	37.8	35.2	35.9	36.6	37.3	38.0	38.7	39.4	42.9	46.4	49.9
NORTH DAKOTA	24.7	25.0	27.8	25.6	26.3	27.0	27.7	28.4	29.1	29.9	33.4	37.0	40.5
OHIO	40.0	43.0	43.4	44.0	44.3	44.6	44.9	45.1	45.4	45.7	47.1	48.6	50.0
OKLAHOMA	24.0	24.0	24.4	24.6	24.8	25.0	25.2	25.5	25.7	26.0	27.0	27.9	28.8
PENNSYLVANIA	30.0	33.0	34.2	33.6	33.8	34.1	34.4	34.7	35.1	35.4	36.9	38.1	39.3
SOUTH DAKOTA	13.2	22.0	25.3	23.0	23.6	24.2	24.8	25.5	26.1	26.9	29.9	32.3	34.7
TENNESSEE	37.0	33.0	35.0	34.1	34.4	34.8	35.1	35.5	35.8	36.2	37.9	39.7	41.4
WEST VIRGINIA	32.0	34.0	34.3	34.2	34.7	35.1	35.6	36.1	36.6	37.0	39.4	41.7	44.1
WISCONSIN	34.8	38.0	38.7	39.2	39.7	40.2	40.6	41.1	41.6	42.1	44.5	46.9	49.3
TOTAL	28.4	29.8	31.7	30.2	30.8	31.4	31.9	32.4	33.1	33.7	36.7	39.7	42.7

WHEAT PRODUCTION IN MILLIONS OF BUSHELS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	3.4	3.1	4.1	4.3	4.5	4.7	4.9	5.1	5.2	5.3	5.5	5.8	6.1
ARKANSAS	27.7	21.7	16.1	15.4	15.1	15.0	15.1	15.2	15.3	15.6	16.3	17.0	18.7
ILLINOIS	72.2	59.2	36.3	48.5	55.0	54.8	53.0	52.0	53.2	53.3	60.1	68.4	79.2
INDIANA	57.6	46.8	29.8	36.6	43.6	42.8	41.5	40.7	43.0	43.6	54.3	65.3	79.4
IOWA	3.0	2.3	1.1	1.2	1.9	1.7	1.5	1.3	1.4	1.4	2.2	3.4	4.8
KANSAS	339.0	393.6	346.0	373.4	382.3	390.8	399.8	408.8	417.9	425.9	468.8	509.9	552.4
KENTUCKY	10.2	9.2	9.2	10.3	10.2	10.0	10.0	9.9	10.2	10.2	11.1	11.5	12.2
LOUISIANA	1.2	1.0	0.8	0.8	0.8	0.6	0.4	0.7	0.3	0.3	0.3	0.3	0.3
MINNESOTA	130.6	112.4	59.1	107.1	109.9	114.6	121.0	124.2	131.0	128.7	139.7	146.5	155.3
MISSISSIPPI	5.2	3.8	4.7	5.1	5.0	4.6	4.2	4.0	3.7	3.4	2.9	2.3	1.7
MISSOURI	54.5	52.7	23.5	36.0	43.0	43.9	43.2	43.0	44.4	44.9	52.5	62.1	74.2
NEBRASKA	94.4	106.8	95.6	104.1	105.9	107.3	108.4	110.2	111.5	113.6	122.1	129.4	136.3
NORTH DAKOTA	287.9	240.7	238.3	247.5	277.2	294.5	312.4	331.5	340.6	349.8	395.9	443.1	491.3
OHIO	66.0	66.2	42.2	58.4	61.5	60.2	58.1	57.1	58.1	58.2	63.6	69.2	77.1
OKLAHOMA	151.2	156.0	122.0	160.2	163.1	165.9	168.9	172.0	174.1	175.6	183.6	189.0	195.0
PENNSYLVANIA	9.5	8.6	7.0	7.7	7.2	6.7	6.1	5.6	6.0	6.3	7.9	9.4	11.1
SOUTH DAKOTA	39.5	66.3	64.7	70.8	73.6	76.7	79.6	82.8	85.7	88.5	101.8	113.1	125.1
TENNESSEE	12.4	9.2	7.1	10.8	11.1	11.3	11.6	11.9	12.3	12.6	14.2	15.8	17.6
WEST VIRGINIA	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.6
WISCONSIN	3.2	3.0	1.0	2.4	2.7	2.7	2.8	2.8	3.1	3.2	4.2	5.1	6.3
TOTAL	1368.9	1363.0	1109.0	1301.8	1373.9	1409.1	1443.0	1479.3	1517.6	1540.6	1707.5	1867.0	2044.8

WHEAT PRODUCTION IN MILLIONS OF SHORT TONS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
ALABAMA	0.10	0.09	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18
ARKANSAS	0.63	0.65	0.48	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.49	0.51	0.56
ILLINOIS	2.16	1.78	1.09	1.45	1.65	1.64	1.59	1.56	1.60	1.60	1.80	2.05	2.38
INDIANA	1.73	1.40	0.89	1.10	1.31	1.29	1.25	1.22	1.29	1.31	1.63	1.96	2.38
IOWA	0.09	0.07	0.03	0.04	0.06	0.05	0.04	0.04	0.04	0.04	0.07	0.10	0.14
KANSAS	10.17	11.81	10.38	11.20	11.47	11.72	11.99	12.26	12.54	12.78	14.06	15.30	16.57
KENTUCKY	0.31	0.28	0.28	0.31	0.31	0.30	0.30	0.30	0.31	0.31	0.33	0.34	0.37
LOUISIANA	0.03	0.03	0.02	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01
MINNESOTA	3.92	3.37	1.77	3.21	3.30	3.44	3.63	3.73	3.93	3.86	4.19	4.40	4.66
MISSISSIPPI	0.16	0.11	0.14	0.15	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.07	0.05
MISSOURI	1.63	1.58	0.71	1.10	1.29	1.32	1.29	1.29	1.33	1.35	1.58	1.86	2.23
NEBRASKA	2.83	3.20	2.87	3.12	3.18	3.22	3.25	3.31	3.35	3.41	3.66	3.88	4.09
NORTH DAKOTA	8.64	7.22	7.15	7.43	8.31	8.64	9.37	9.95	10.22	10.49	11.88	13.29	14.74
OHIO	1.98	1.99	1.27	1.75	1.84	1.81	1.74	1.71	1.74	1.74	1.91	2.08	2.31
OKLAHOMA	4.54	4.68	3.66	4.80	4.89	4.98	5.07	5.16	5.22	5.27	5.51	5.67	5.85
PENNSYLVANIA	0.28	0.26	0.21	0.23	0.22	0.20	0.18	0.17	0.18	0.19	0.24	0.28	0.33
SOUTH DAKOTA	1.18	1.99	1.94	2.12	2.21	2.30	2.39	2.48	2.57	2.65	3.05	3.39	3.75
TENNESSEE	0.37	0.28	0.21	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.43	0.47	0.53
WEST VIRGINIA	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
WISCONSIN	0.10	0.09	0.03	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.13	0.15	0.19
TOTAL	41.07	40.89	33.27	39.05	41.22	42.27	43.29	44.38	45.53	46.22	51.22	56.01	61.34

APPENDIX D

SECTION V

ECONOMETRIC FORECASTING EQUATIONS, COAL PRODUCTION AND COAL CONSUMPTION

COAL PRODUCTION EQUATIONS

(Table of Variable Coefficients)

State (CP**A)	CONSTANT	Independent Variables							$\bar{R}^2$	DW	SE
		WPIBT	XIPUTIL	XIPIRON	XIPBITU	QSA/WPIBT	XIPUTIL/WPIBT	WAGE/WPIBT			
IL	27.5 (5.19)	-65.5 (3.75)	217.9 (3.58)	170.6 (1.93)					.876	1.81	2.9
IN	6.3 (1.27)				190.4 (5.31)	-4.1 (2.56)			.850	0.52	1.7
OH	22.3 (10.37)	-67.5 (5.08)	288.7 (8.92)						.865	1.40	2.9
PA	35.6 (7.35)			99.1 (1.23)	313.0 (3.59)				.808	0.64	3.2
WV	72.5 (11.32)						73.7 (8.89)		.823	1.54	7.0
KY	-6.4 (0.67)		248.1 (2.78)		1045.2 (5.21)			-633.3 (3.20)	.991	1.60	3.0
VA	25.8 (16.64)	-20.6 (2.08)	98.5 (4.08)						.599	0.87	2.1
TN	3.8 (5.88)	-6.3 (1.50)	42.1 (4.16)						.670	1.34	0.9
KS	0.7 (6.92)	-5.1 (7.58)	10.5 (6.44)						.782	1.92	0.1
OK	2.7 (2.67)				17.6 (2.76)			-82.5 (5.38)	.828	1.15	0.3

Note: t-values for variables are in parentheses, below coefficient values.

State (CP**A)	CONSTANT	Independent Variables							$\bar{R}^2$	DW	SE
		WPIBT	XIPUTIL	XIPIRON	XIPBITU	QSA/WPIBT	XIPUTIL/WPIBT	WAGE/WPIBT			
MO	1.8 (5.27)				36.9 (9.36)	-1.3 (7.07)			.960	2.45	0.2
AL	0.3 (0.09)				197.1 (8.67)	-2.2 (2.14)			.919	1.27	1.1
ND	0.6 (0.25)				99.6 (5.99)	-3.4 (4.33)			.909	0.92	0.8

Note: t-values for variables are in parentheses, below coefficient values.

COAL CONSUMPTION EQUATIONS

(Table of Variable Coefficients)

State (CSH**)	Independent Variables						$\bar{R}^2$	DW	SE
	CONSTANT	METAL**	WPIEL/WPING	WPIEL/WPIPT	EMPLOY**	SCBCT**			
ND/SD	-4.5 (1.36)		-5.2 (1.65)		41.9 (16.76)		.963	1.19	0.4
NE/KS	-0.5 (0.15)			-31.4 (1.38)	5.2 (2.99)		.715	1.02	0.6
MO	-15.1 (1.1[illegible]			-84.[illegible] (1.25)	22.4 (4.55)		.769	0.71	2.2
MN	11.1 (1.61)	18.4 (1.27)	-7.5 (1.47)	-31.8 (1.65)	5.1 (3.31)		.895	1.18	0.5
WI	37.6 (3.3[illegible]		-22.8 (2.22)		6.3 (1.03)		.370	1.42	1.2
IL	82.3 (4.90)	8.5 (2.62)	-50.6 (5.12)				.586	1.68	1.9
KY	45.6 (2.86)	77.8 (9.14)	-40.1 (2.54)				.885	1.48	1.9
TN	28.[illegible] (1.77)		-30.1 (1.94)		15.6 (5.92)		.782	1.11	1.9
MS/AL	29.9 (2.25)		-33.1 (2.59)		18.2 (9.29)		.895	1.32	1.5
IN	24.9 (1.17)		-23.3 (1.50)	-13.1 (1.23)	22.7 (7.27)		.891	2.64	1.8

Note: t-values for variables are in parentheses, below coefficient values.

State (CSH**)	Independent Variables						$\bar{R}^2$	DW	SE
	CONSTANT	METAL**	WPIEL/WPING	WPIEL/WPIPT	EMPLOY**	SCBCT**			
PA	15.9 (0.61)		-17.2 (0.78)		14.6 (5.89)		.774	1.22	2.6
MI	7.6 (3.57)		-50.8 (2.65)		3.1 (1.48)		.486	1.30	2.3
IA	0.8 (1.11)				6.0 (7.57)		.827	1.33	0.3
OH	13.6 (2.72)				20.0 (14.79)		.948	2.65	1.8
WV	-52.0 (11.93)				150.47 (17.65)		.963	1.65	1.3
VA	0.5 (0.30)					144.2 (6.24)	.764	0.21	1.5

Note: t-values for variables are in parentheses, below coefficient values.

VARIABLE DEFINITIONS FOR COAL PRODUCTION AND CONSUMPTION EQUATIONS

CSH** = Annual consumption of all kinds of coal in millions of short tons

CP**A = Annual production of coal, millions of short tons

METAL** = Value added, primary metals, in millions of 1967 dollars

WPIEL = Wholesale price index, electricity

WPING = Wholesale price index, natural gas

WPIPT = Wholesale price index, petroleum

WPIBT = Wholesale price index, industrial sizes of bituminous coal

EMPLOY** = Total employment, in thousands

XIPUTIL = Index of industrial production, utilities

XIPBITU = Index of industrial production, bituminous coal

XIPIRON = Index of industrial production, iron and steel

SCBCT** = Coal's share of total fuel generation

WAGE = Wage rate, coal mining

QSA = CEAI index, cost of capital structures

** In each variable, ** refers to state labels, such as "AL" for Alabama, etc.

MID-AMERICA PORTS STUDY

APPENDIX E

COMMODITY FORECAST METHODOLOGY

THE MID-AMERICA PORTS STUDY
COMMODITY FORECAST METHODOLOGY

CONTENTS

I. INTRODUCTION

- A. Forecast Objective
- B. Basic Approach
- C. Preliminary Processing Steps

II SELECTION OF THE FORECAST METHODOLOGY

- A. Major Considerations
- B. Hardware and Software Support

III THE PRELIMINARY BASELINE FORECAST

- A. Regression and Review of Historical Activity
- B. Forecasting Procedures

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V. REVISION OF THE PRELIMINARY BASELINE FORECAST

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- B. Comparison of Preliminary Forecast and Historical Flows
- C. Adjustment of Selected Flows

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E. Summary

X. LIMITATIONS AND AREAS FOR FUTURE IMPROVEMENT IN THE DATABASE AND FORECAST METHODOLOGY

A. Overview

B. Limitations

C. Areas for Future Development

I. INTRODUCTION

This Appendix presents the methodology and procedures employed in the preparation of the Mid-America Ports Study commodity forecast for use in determining future waterside facility and terminal requirements. It is intended to serve as both a record of efforts undertaken in the Mid-America Ports study and a guide to opportunities for revisions and refinement of the forecast in the future.

A. FORECAST OBJECTIVE

The forecast of domestic inland waterway freight traffic to the year 2000 was prepared as the determinant of future demand for terminal facilities along the waterways of the Mid-America states. The forecast is therefore a key element in the study, and a forecast incorporating the latest and previously unavailable opportunities for accurate forecasting was developed to support study objectives.

The significant departures from previous forecasts of domestic trade are the scope of the forecast and the utilization of historical waterborne commerce and economic activity at previously unavailable levels of detail as its foundation. This detail was developed through the creation of a comprehensive definition of the waterways within the Mid-America Region, the raillines and pipelines that complement and compete with the waterways, the economic activity of states within the Mid-America region, and other factors impacting the recent history and future of the waterways.

B. BASIC APPROACH

The fundamental operation employed in forecasting inland waterway freight traffic was to establish relationships between historical domestic waterborne commerce and independent historical econometric indicators for the eight-year time period 1969-1976.

On a national level the historical correlation between internal domestic waterborne activity and the growth of the gross national product (GNP) has been a close one. Exhibit 1 presents a comparison of GNP to internal domestic ton-miles

Exhibit 1

INTERNAL DOMESTIC WATERBORNE TON-MILES CARRIED
COMPARED WITH REAL GROSS NATIONAL PRODUCT
U.S. Internal Waterways Traffic

Year	GNP in $1971	Ton-miles (billions)	Tons (millions)	Average Distance (miles)	Ton-Miles/ $100 GNP	Tons/ $100,000 GNP
1961	704.3	84.3	294.1	287	12.0	41.8
1962	750.6	89.6	316.1	283	11.9	42.1
1963	780.3	94.4	331.9	284	12.1	42.5
1964	823.0	101.9	357.9	285	12.4	43.5
1965	873.4	109.7	369.6	297	12.6	42.3
1966	924.2	117.3	389.9	301	12.7	42.2
1967	956.2	128.3	398.6	322	13.4	41.7
1968	1,000.7	139.3	430.2	323	13.9	43.0
1969	1,027.6	144.0	460.9	312	14.0	44.8
1970	1,022.6	155.8	472.1	330	15.2	46.2
1971	1,050.4	161.3	479.2	337	15.4	45.6
1972	1,113.8	177.5	507.0	350	15.9	45.5
1973	1,174.5	171.9	503.2	342	14.6	42.8
1974	1,154.5	183.2	511.0	359	15.8	44.3
1975	1,133.2	180.4	503.9	358	15.9	44.5
1976	1,218.7	197.1	524.0	376	16.2	43.0

NOTE: Internal traffic is traffic between ports or landings wherein the entire movement takes place on inland waterways. Also included are movements involving carriage on both inland waterways and waters of the Great Lakes; inland movements that cross short open waters which link inland systems; marine products, sand and gravel taken directly from beds of the oceans, the Gulf of Mexico and important arms thereof; and movements between offshore installations and inland waterways.

Source: GNP - Board of Governors of the Federal Reserve System.
Inland Traffic - U.S. Army Corps of Engineers, Waterborne Commerce of the United States Part 5, National Summaries

and tons carried 1961-1976. The increasing length of inland voyages during this period contrasts with the steady ratio of tons carried on the waterways relative to the GNP. This constant relationship is indicative of the firm foundation upon which the Mid-America Ports Study econometric forecasting procedures are based. These relationships were then used to predict baseline future waterborne commerce on the basis of forecasted econometric indicators. This baseline forecast was then revised and updated to reflect environmental and competitive factors as well as the completion of new waterways. Exhibit 2 graphically presents the components and relationships of the traffic forecast, given the availability of a regressible eight-year flow history for a state commodity direction.

C. PRELIMINARY PROCESSING STEPS

To establish historical relationships between econometric and demographic indicators and domestic waterborne commerce, a number of steps were required prior to commencing the forecasting procedure.[1] For the waterborne commerce side of the equations, commodity groups and geographic areas (subregions) were developed by aggregating more than 150 commodities and 3,500 Army Corps of Engineer channels in the 17 Mid-America states. Exhibit 3 presents the 20 commodity groups and Exhibit 4 summarizes the 89 subregions in the Mid-America area. An array of historical and forecast econometric and demographic independent variables was prepared for each of the Mid-America states by Chase Econometric Associates, Inc. as shown in Exhibit 5.

[1]The methodologies employed in the development of commodity groups, subregions, railroad capacity, and the econometric and demographic variables that formed the basis for forecasting are described in detail in companion chapters.

Exhibit 2

MID-AMERICA PORTS STUDY
FORECAST METHODOLOGY

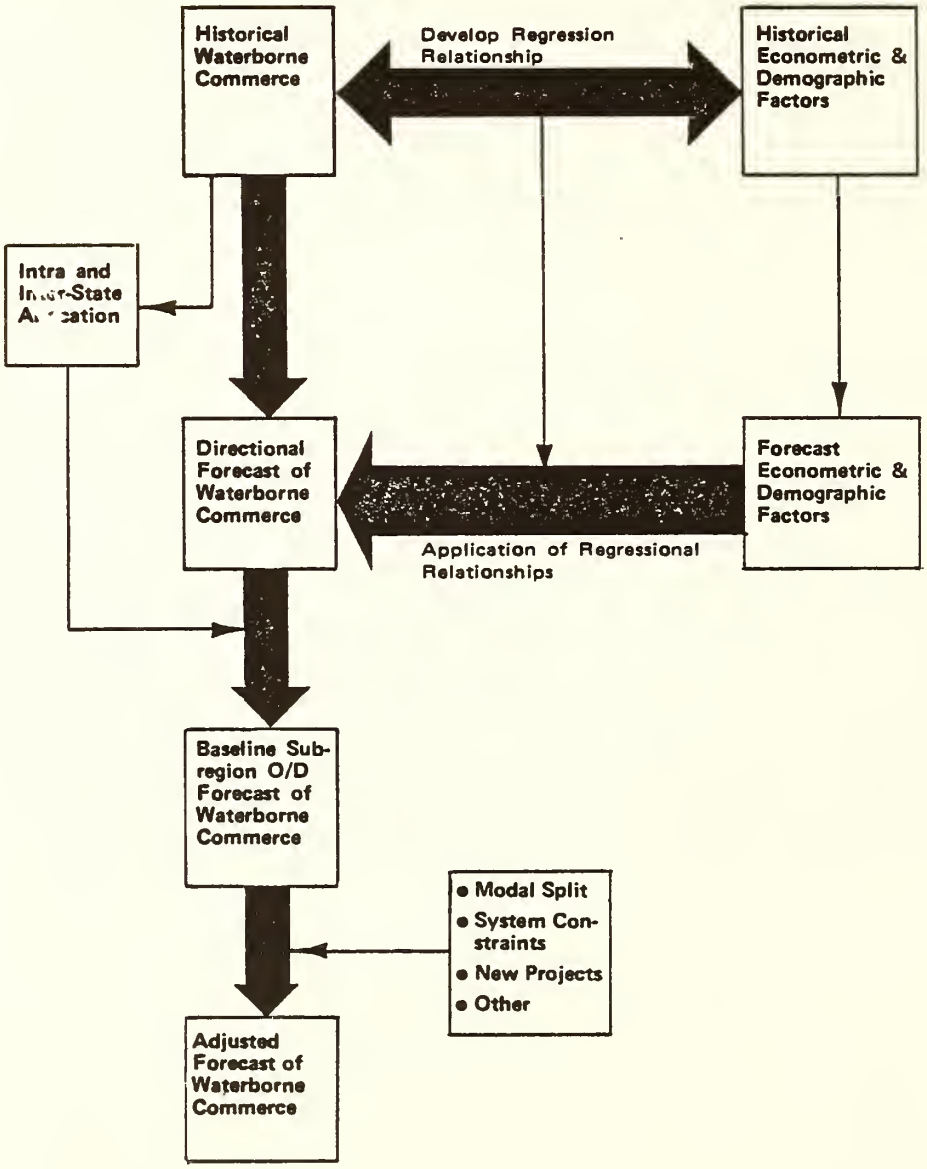

Historical Waterborne Commerce
Develop Regression Relationship
Historical Econometric & Demographic Factors
Intra and Inter-State Allocation
Directional Forecast of Waterborne Commerce
Forecast Econometric & Demographic Factors
Application of Regressional Relationships
Baseline Sub-region O/D Forecast of Waterborne Commerce
• Modal Split
• System Constraints
• New Projects
• Other
Adjusted Forecast of Waterborne Commerce

Exhibit 3

MID-AMERICA COMMODITY GROuPS

Commodity Group Code	Commodity Group Description
1	Cash Grains
2	Iron and Non-ferrous Metal Ores and Concentrates
3	Bauxite and Aluminum Ores
4	Coal and Coal Products
5	Crude Petroluem
6	Petroleum Products and Lubricants
7	Industrial Chemicals
8	Agricultural Chemicals/Fertilizers
9	Milled Grain and Agricultural Products, NEC
10	Lumber and Wood Products
11	Sugar and Molasses
12	Primary Ferrous and Non-ferrous Metal Products
13	Fabricated Metal Products
14	Scrap Metals
15	Construction Materials
16	Mining Products, NEC
17	Non-durable Manufactures NEC, including Processed Foods
18	Durable Manufactures, NEC
19	Waste and Scrap Materials, Miscellaneous
20	Waterway Improvement and Government Materials

Exhibit 4

MID AMERICA PORTS STUDY

SUBREGIONAL ASSIGNMENTS AND RIVER MILE DELINEATIONS

Subregion	1975 Tons Sent	1975 Tons Received	Down River Mile	Up River Mile	River
			Alabama		
011	5	57	65118*	65169	GIW
012	11,304	9,377	0	45.0	Mobile
013	2,014	830	45.0	305.1	Alabama
014	7,469	6,757	45.0	430.0	Black War.
015	3,550	7,273	215.1	416.5	Tenn.
016	95	1	217.0[a]	-	Tenn/Tom
017	0	0	305.1	-	Coosa
018	335	787	25.5	155.0	Appa/Chatta/Flint
			Arkansas		
041	464	16	506.0	501.3	Miss.
042	1,302	2,311	0	125.4	Ark.
043	1,150	1,275	125.4	308.5	Ark.
044	2,152	1,053	581.3	715.0	Miss.
045	958	162	715.0	828.0	Miss.
046	739	425	9.8	84.0	White
047	0	0	-	-	Ouach.
			Illinois		
131	1,757	277	361.5	580.7	Miss.
132	5,788	1,121	179.0	361.5	Miss.
133	12,086	4,501	0	157.7	Ill.
134	12,119	5,487	157.7	291.0	Ill.
135	12,504	28,472	291.0	327.2	Chicago Canals
				333.4	Cal-Sag Canal
136	32	18	117.5	179.0	Miss.
137	6,066	371	953.8	117.5	Miss.
138	795	3,562	981.0	935.0	Ohio
139	7,010	142	935.0	848.0	Ohio
1310	0	0	-	-	Kaskaskia River
			Iowa		
151	5,030	4,065	361.5	580.7	Miss.
152	190	163	580.7	673.7	Miss.
153	104	222	552.4	734.0	Mo.

(continued)

Subregion	1975 Tons Sent	1975 Tons Received	Down River Mile	Up River Mile	River
			Kansas		
161	189	46	367.7	489.8	Mo.
			Kentucky		
170	2,898	1,836	491.2	317.0	Ohio
171	3	574	0	249.0	Kentucky
172	5,302	10,658	784.5	491.2	Ohio
173	72	72	385.5	542.0	Cumb.
174	5,864	1,383	935.0	784.5	Ohio
175	15,891	287	0	149.5	Green
176	428	1,082	981.0	935.0	Ohio
177	142	114	905.0[b]	953.8	Miss.
178	4,993	947	0	62.6	Tenn.
179	2,346	79	0	74.7	Cumb
1710	0	0	149.5	168.1/30.0[c]	Green
			Louisiana		
181	31,495	20,635	d	d	Misc.
182	33,806	22,469	0	88.0	Misc.
183	47,129	67,007	95	305.0	Miss.
184	74	140	305.0	426.0	Miss.
185	210	234	426.0	506.0	Miss.
186	3,628	1,380	f	f	Misc.
187	609	493	g	g	Ouachita
188	0	0	h	h	Red to Shreveport
189	0	0	h	h	Red to Diangerfied
			Minnesota		
231	718	954	673.8	811.3	Miss.
232	9,823	6,690	811.3	858/26[i]	St. Croix
			Mississippi		
241	382	623	305.0	426.0	Miss.
242	1,155	3,693	426.0	506.0	Miss.
243	518	2,336	506.0	715.0	Miss.
244	9,015	5,068	65035	65118[j]	GIW
245	0	0	0	k	Tenn/Tom
246	0	0	9.8	Project	Yazoo

(continued)

Subregion	1975 Tons Sent	1975 Tons Received	Down River Mile	Up River Mile	River
			Missouri		
251	778	1,872	828.0	905.0	Miss.
252	273	142	905.0	953.8	Miss.
253	903	661	953.8/0.0	117.5	Miss.
254	12,401	7,321	117.5	179.0	Miss.
255	1,794	1,760	0	227.0	Mo.
256	2,164	1,371	227.0	367.7	Mo.
257	2,128	724	179.0	361.5	Miss.
258	480	397	367.7	489.8	Mo.
259	47	196	489.8	552.4	Mo.
			Nebraska		
271	498	549	552.4	734.0	Mo.
272	0	39	489.8	552.4	Mo.
			Ohio		
351	4,082	15,206	491.2	317.0	Ohio
352	189	86	317.0	265.7	Ohio
353	3,715	8,611	265.7	126.4	Ohio
354	7,629	7,007	126.4	40.0	Ohio
			Oklahoma		
361	640	362	308.5/40.0	(91.5)/50.3	Ark.
			Pennsylvania		
381	1,078	7,090	40.0	13.3	Ohio
382	10,806	25,875	13.3	69.0/23.8[l]	Misc.
383	17,429	8,268	23.8	90.8[m]	Monong.
			Tennessee		
421	177	157	715.0	828.0	Miss.
422	2,111	9,934	828.0	905.0	Miss.
423	1,102	4,758	62.6	215.1	Tenn.
424	269	9,169	74.7	385.5	Cumb.
425	2,187	2,460	416.5	529.9	Tenn.
426	398	1,265	529.9	69/649.0[n]	Tenn.

(continued)

Subregion	1975 Tons Sent	1975 Tons Received	Down River Mile	Up River Mile	River
			West Virginia		
481	6,176	9,174	0	90.57	Kawha
482	13,371	1,216	317.0	265.7	Ohio
483	4,326	3,826	265.7	126.4	Ohio
484	6,324	4,107	126.4	40.0	Ohio
485	8,787	3,315	90.8	115.4/128.0[o]	Monong.
			Wisconsin		
491	434	704	580.7	673.8	Miss.
492	119	1,482	673.8	811.3	Miss./Black
89 subregions					

*Channel codes describing Alabama limits of Gulf Intracoastal Waterway.

[a]Tenn/Tombigbee Waterway, commencing at mile 217.0 on the Black Warrior River and ending at the Alabama/Mississippi border (under construction).

[b]Milepost 905 on the Mississippi River.

[c]Milepost 168.1 on the Green River and Milepost 30.0 on the Barren River.

[d]See Subregional Assignment Map of Louisiana. Subregion 181 includes the Gulf Intracoastal Waterway West of the Mississippi, and the Calcasiev, Freshwater, Vermillon, Houma, LaFourche, Bataria, Harvey and Algiers waterways as well as all western coastal counties.

[e]Subregion 182 includes Pearl River to Milepost 95, the Mississippi River to Milepost 88.0, the Mississippi River Outlet, and the Rigolet and Gulf Intercoastal waterways east of New Orleans.

[f]Subregion 186 comprises the Atchafalaya, Bayou Teche and Le Grande waterways.

[g]Subregion 187 is assigned to the Ouachita River in Louisiana.

[h]Subregion 188 is assigned to the Mississippi River-Shreveport, Louisiana Reach of the Red River. Subregion 189 is assigned to the Shreveport, Louisiana to Diangerfield, Texas Reach of the Red River.

[i]Milepost 26 on the St. Croix River, and Mileposts 858 (last commercial facility) on the Mississippi River.

[j]Channel codes describing Mississippi limits of Gulf Intracoastal Waterway.

[k]Tenn/Tombigbee Project.

[l]Milepost 69.0 on the Allegheny River and Milepost 23.8 on the Monongahela. Milepost 13.3 on Ohio River.

[m]Milepost 90.8 on Monongahela River (Pennsylvania/West Virginia border).

[n]Milepost 69.0 on Clinch River. Milepost 649 on Tennessee River.

[o]Milepost 115.4 on the Monongahela at Opekiska Lock and Dam, Milepost 128.0 at head of navigation.

Exhibit 5

PRINCIPAL ECONOMETRIC AND DEMOGRAPHIC INDEPENDENT VARIABLES

Historical 1969-1976
Forecast 1980-2000

National Variables	State Variables by Commodity and Industry
Grain Exports (soybean equivalent tons)	Coal Production and Consumption (thousands of tons)
General Exports (billions of 1972 dollars)	Cash Grain Production (thousands of tons)
	Total Housing Starts (hundreds of units)
	Shipments of Manufactured Goods (millions of 1967 dollars)
	Consumption of Fertilizers (nutrient tons)

SIC Code Value Added in Manufactured Goods by State
(millions of 1958 dollars)

Code		Code	
20	Foods	29	Petroleum Products
21	Tobacco Products	30	Rubber and Plastic Products
22	Textile Mill Products	31	Leather and Products
23	Apparel Products	32	Clay, Glass, Stone Products
24	Lumber and Products	33	Primary Metals
25	Furniture and Fixtures	34	Fabricated Metal Products
26	Paper and Products	35	Non-electrical Machinery
27	Printing and Publishing	36	Electrical Machinery
28	Chemical Products	37	Transportation Equipment
		38	Instruments

II. SELECTION OF THE FORECAST METHODOLOGY

A. MAJOR CONSIDERATIONS

There were several major considerations which influenced the development of the selected forecast methodology. These included:

- The total number of potential subregional pair commodity flows (443,760)
- The total number of potential regional[2] pair commodity flows (21,540)
- The total number of potential intra, inbound, and outbound commodity flows for each region (1,100)
- The econometric and demographic historic and forecast values were available by region (state or whole United States)
- The small number of actual commodity flows observed relative to the potential in each of the above cases.

The density of observations and availability of econometric data proved to be the two deciding factors. Econometric and demographic data are not available at the subregional level; which precluded using this level of detail as the basis for the primary forecast. At the regional level two alternatives were explored:

- Primary forecast of state pair movements; and
- Primary forecast of state inbound or outbound, and intra movement; with the forecast of state pair movements being developed from the allocation of inbound movements to their source state and outbound movements to their destination states based on historical state pair flow patterns.

[2]Each region corresponds to a state in the Mid-America area.

The low density of the state pair flow data resulted in the selection of the second alternative. Even at this level of detail 368 state pair potential flows (67 inbound, 90 outbound, and 211 intra), exhibited no traffic in 1975 or 1976. An additional 178 potential flows indicated intermittent traffic movements during 1969-1976. This left only 544 potential commodity flows which indicated continuous activity during 1969-1976. The density of full eight-year flows at the state pair level is significantly below the 49 percent represented by the 544 flows based on state and direction. Exhibit 6 presents a tabular summary of the density of state/commodity/directions 1969-1976.

This selection process resulted in the development of a methodology which has three basic steps:

1. The forecast of intra and inbound or outbound movements for each region.

2. The development of state-to-state movements and the destinations of outbound movements (and sources of inbound movements) from each state by trending the historic flow patterns between the states.

3. The development of subregion-to-subregion movements under the umbrella of each state pair using trended distributions of the total state pair flow.

These steps are applied to each state, commodity, and direction of flow including intrastate movements.

B. HARDWARE AND SOFTWARE SUPPORT

The size and complexity of the forecast required ready access to the historical and forecast database for primary forecast development and efficient processing and storage of allocated state and subregional pair flow patterns. A CDC 6000 time sharing computer system with proprietary data management and analytical packages was utilized for all state/commodity/direction analysis. Access to the system was by terminal and all historical information at the state level, including historical commodity flows by direction and econometrics were loaded manually. Exhibit 7 graphically presents the general characteristics of the database. Forecast values of state activity were developed and stored in this database.

Exhibit 6

MID-AMERICA
STATE/COMMODITY/DIRECTION
DENSITY
1969-1976

	01 Cash Grains	02 Ores	03 Non-Metallic Ores	04 Coals	05 Crude Oil	06 Petro Products	07 Industrial Chemicals	08 Agricultural Chemicals	09 Milled Grain	10 Lumber	11 Sugar Mol.	12 Primary Metals	13 Fabricated Metals	14 Scrap Metals	15 Co. Nst. Metals	16 Mining Products	17 Non-Dur. Manufacturers	18 Dur. Manufacturers	19 Waste	20 Nat. Imp. Metals	
Alabama 01	F F F	F F F	- 1 3	F F F	F F F	F F F	F F F	⑤² F F	F F F	F ⑤² F	②⁵ 7 ②⁵	F F F	F F F	F F F	F F F	F F F	F F F	F F F	2 F F	5 7 5	01
Arkansas 04	3 F F	- ⑥ -	- ⑦ 2	1 2 ②	- 1 3	①² F F	1 F F	1 F F	- ⑤ F	F ②³ F	- ②³ 1	6 F ⑦	⑦ F 4	2 2 ①	F ⑦⑦³	- ⑦ ②	- ⑥ F	1 ⑦ 4	1 ⑤¹ 2	⑦ F F	04
Illinois 13	F F F	2 F③⁴	- 3 1	F F F	③¹ 3③²	F F F	F F F	F F F	F F F	4 F F	③² F ④³	F F F	③⁴ F F	F F F	F F F	F F F	②⁵ F F	③¹ F F	⑥ F F	F F F	13
Iowa 15	2 F F	- F 3	- - -	②¹ F ③¹	- - -	2 F F	1 F F	5 F F	1 F F	6 ①⁴ ③²	- F 1	1 F F	1 ③² ⑦	- F F	F F F	- F -	- F F	- 3 2	- 1 3	F F F	15
Kansas 16	- 1 ③⁴	- - -	- - -	- - -	- - -	- - -	- - -	- 7 -	- - 1	- - -	- F 1	- - -	- 2 -	- - -	1 1 6	- 1 -	- - -	- - -	- - -	1 5 F	16
Kentucky 17	5 F F	1 F F	- ③ 1	F F F	6 ③² 7	F F F	F F F	②³ F F	- F F	1 5 F	- F -	5 F F	F F F	4 F F	F F F	② F ⑦	1 F F	5 F F	1 ③² F	F F F	17
Louisiana 18	F F F	F F F	- 5 F	⑤ F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F F	F F 7	18
Minnesota 23	F ④³ F	- 1 2	- - -	F F F	- ③ 1	F F F	- F 4	1 F F	1 F F	- 4 -	- F F	1 F ⑥	- 6 ②⁵	1 F F	F F 2	- F 1	- F F	- 3 2	- ② 1	- - -	23
Mississippi 24	F F F	- ②² ④³	- - 1	- F 2	- ⑤² F	F F F	- F F	F F F	F F F	F F F	- 1 1	F F F	F F F	1 5 F	F F F	- F 7	F F F	F F F	④² F F	F F F	24
Missouri 25	F F F	- F 5	- 1 1	F F F	- 2 1	F F F	F F F	F F F	③³ ③⁴ F	②² F F	1 F 4	F F F	5 F F	- 7 F	F F F	- F ⑦	1 F F	- ⑤ ④³	- F ④²	F F F	25
Nebraska 27	- ① F	- 1 -	- - -	- 1 -	- - -	- 1 -	1 F 1	②¹ F F	- 4 F	- - -	- F 1	1 F 2	- ③⁴ 3	- - 1	- F -	- F 1	- F F	- 1 2	- - -	7 F F	27
Ohio 35	- F F	3 F F	- 5 -	F F F	1 ⑤² 7	F F F	6 F F	⑤ F 7	- F③³	1 6 ⑤¹	- F 3	F F F	6 F F	F F F	F F F	1 F F	- F ⑦	4 F ⑦	2 F F	4 5 4	35
Oklahoma 36	- 1 ⑥	- 1 -	- - -	- - ⑥	- - -	- 3 ⑤	- ⑥ ⑤	- ⑥ 1	- - ④	- ② 1	- ⑥ 1	⑥ ⑤ ②³	1 ⑤ ⑥	- 1 1	⑤ 1③¹	- 2 -	- 5 -	- 3 ⑥	- 2 1	3 2 ⑤	36
Pennsylvania 38	- 1 -	4 F F	- 1 -	F F F	- F 3	F F F	F F F	- F 5	- F -	2 6 2	- F -	F F F	F F F	F F F	F F F	6 F④²	- ⑦⁵ F	3 F F	6 F⑤¹	3 4 F	38
Tennessee 42	F F F	- F F	- 1 2	④ F F	- F -	F F F	④² F F	2 F F	2 F F	F F F	- F⑤¹	⑤² F F	F F F	- F F	F F F	1 F F	5 F F	③² F F	1 ⑤¹④³	F F F	42
W. Virginia 48	- - 2	- F F	- 1 -	F F F	2 F 7	F F F	F F F	1 3 F	- - 1	- 4 3	- 1 -	- F F	③⁴ F F	④² F F	F F F	1 F 5	- 2 1	1 F②³	③² F F	7 F 5	48
Wisconsin 49	- 5 F	- - -	- - -	- F 4	- - -	- F 4	- - 1	- F 2	- - 2	- - 2	- 1 -	- F 1	- 5 4	- - F	- ⑥ 2	- F -	- - -	- 3 1	- - ②	- - -	49
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	

KEY:

COMMODITY

STATE | INTERSTATE (one direction): Inbound / Outbound

I-7 = Number of Historical Observations

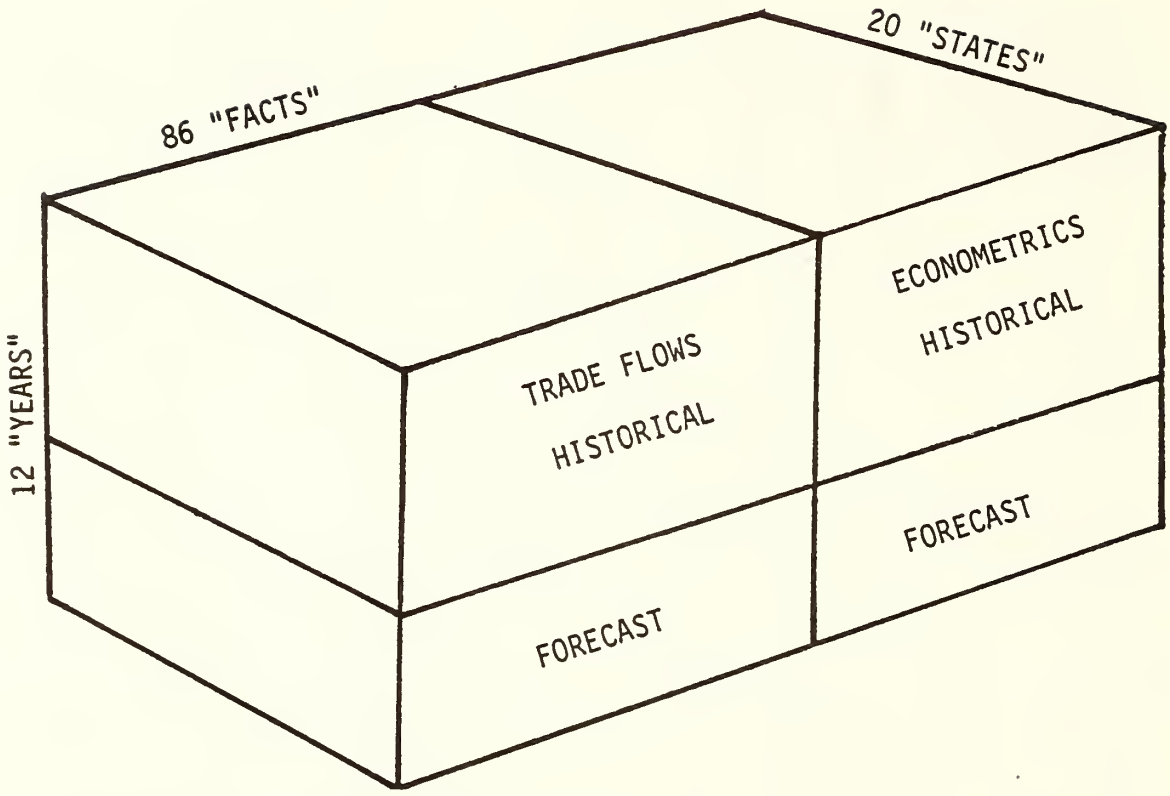
F = Eight Years of Traffic (1969-1976)

Ⓐ^B = Ⓐ Years of Continuous Traffic Ending in 1976
B Additional Observations

- = No Traffic Observations (1969-1976)

Exhibit 7

BASIC FORECAST DATABASE



Time	(8)	1969 through 1976 (historical)
	(4)	1980, 1985, 1990, 2000 (forecast)
	12	Total
States	(17)	Alabama through Wisconsin, the 17 Mid-America States
	(1)	Indiana
	(1)	U.S. Great Lakes
	(1)	U.S. Coastal (Gulf)
	20	Total
Facts	(60)	Commodity Groups 1 through 20, three directions (inbound, outbound, intrastate)
	(26)	Econometrics and demographics, national and state variables
	86	Total

NOTES: Forecasts were developed for intrastate traffic and the designated interstate direction for each commodity.

The actual database was slightly larger to accommodate various work spaces.

III. THE PRELIMINARY BASELINE FORECAST

A. REGRESSION AND REVIEW OF HISTORICAL ACTIVITY

As the initial step in the forecasting process, regressional relationships were sought between historical state/commodity/direction flows and the econometric variables. At least one and as many as four independent econometric variables were regressed against the 60 commodity/directions for each state. Once the more than 1,000 regressions were completed, the results were reviewed to identify either the inbound or outbound interstate directions as the basis for each commodity group's interstate forecast flow. The selected direction then served as one end point in the development of state origin and destination movements. Exhibit 8 summarizes the relationships that were tested by regression.

Selection of interstate direction was based upon the following criteria:

- Only full eight-year flow histories were considered.
- Of these flows, only those with relationships with an adjusted percent variances explained (R^2) equal to or exceeding 50 percent were selected.
- For each commodity, the total 1976 tons represented by these select flows in all the states were summed for the inbound and outbound direction. The direction with the higher percentage of tonnage explained was selected. Because of the "closed system" characteristics of the Mid-America states and non-Mid-America states, "inbound" interstate tonnage equals "outbound" interstate tonnage.[3]
- These directions became the designated directions for all subsequent forecasting work.

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[3] Stated precisely the relationships for interstate tonnage are Outbound Mid-America = Inbound Mid-America + Inbound Outside - Outbound Outside. Reverse directions for the inbound Mid-America tonnage relationship.

Exhibit 8

PRELIMINARY REGRESSIONS

Commodity	Independnet Variables Tested- Interstate and Intrastate
01 Cash Grains	Grain Exports Grain Production Both together
02 Iron and Metallic Uses	Shipments of Mfd Goods (SMG) 33 Primary Metals
03 Nonferrous Ores	No histories qualified for regression.
04 Coal	Coal Consumption Coal Production SMG
05 Crude Petroleum	29 Petroleum Products SMG
06 Petroleum Products	29 Petroleum Products SMG
07 Industrial Chemicals	28 Chemical Production SMG
08 Ag. Chem/Fertilizer	28 Chemical Production Fertilizer Consumption Grain Production
09 Milled Grain	20 Foods Grain Production Fertilizer Consumption
10 Lumber	24 Lumber and Products Housing Starts SMG
11 Sugar & Molasses	20 Foods
12 Primary Metals	33 Primary Metals 34 Fabricated Metal Products SMG
13 Fabricated Metals	34 Fabricated Metal Products SMG
14 Scrap Metals	33 Primary Metals
15 Construction Materials	SMG Housing Starts
16 Mining Products	20 Foods SMG
17 Non-Durable Manufacturer	20 Foods 26 Paper Products
18 Durable Manufactures	SMG
19 Waste Materials	SMG
20 Waterway Improvement Materials	SMG

The regression method was utilized to forecast approximately 65 percent of the interstate and 45 percent of the intrastate flows. Regressions were found to be more useful in explaining the flows of commodities into a centralized region from a number of locations or from a centralized region to a number of locations. The movements of cash grains into Louisiana for export and petroleum products from Louisiana to the Mid-America region are prime examples. Generally, activity of higher value, lower volume commodities were less satisfactorilty explained by historical econometrics. These movements are more sensitive to shipper decisions, inventory stockpiling, and the availability of alternative modes of transportation. These factors tend to dominate the econometric variables that describe absolute demand.

B. FORECASTING PROCEDURES

Upon the completion of the preceding regressions and designation of interstate directions for each commodity, all state/ commodity/direction flows were classified for forecasting as:

Regressable Flows - identified by regressions, these flows were characterized by full eight year histories and an R^2 (adjusted percent variance explained) of 50 percent or more. Forecasting was performed on the basis of the regression developed. Exhibit 9 presents the flows incorporated into the final forecast.

Non-Regressable Flows - where a relationship between the commodity movement and the associated econometric series could not be established which explained more than half of the variance in trade volumes or where there were less than eight years of continuous commodity movements, state econometric growth rates were applied to initialized 1976 trade values. The initialized 1976 trade value was calculated as a weighted average of the historic non-zero movements. The growth rate was determined from the coefficient of the regressed relationship between the log of the associated econometric variable and time.

Zeroed Flows - where no movement was observed in 1975 or 1976 (except where six continuous movements were recorded through 1974), the forecast flows were set at zero for the entire forecast period.

Exhibit 9

REGRESSABLE COMMODITY FLOWS

	Regressed Relationship	R^2	T-Ratio
	01 - Cash Grains		
Alabama (In)	+ Grain Exports	64.9	-3.74
Louisiana (In)	+ Grain Exports + Production	90.0	2.77/5.19
Alabama (Intra)	+ Grain Production	74.8	4.67
Tennessee	+ Grain Production - Grain Exports	54.5	1.87/-3.15
	04 - Coal		
Alabama (Out)	+ Coal Consumption	68.7	4.04
Illinois (Out)	+ Coal Production	64.9	3.73
Kentucky (Out)	+ Coal Consumption	50.7	2.86
Minnesota (Out)	+ Coal Consumption	80.2	5.42
Missouri (Out)	+ Coal Consumption	68.8	4.05
Alabama (Intra)	+ Coal Consumption	78.4	5.14
Minnesota (Intra)	+ Coal Consumption	88.1	7.28
	05 - Crude Petroleum		
Alabama (Out)	+ Manufacturing Shipments	63.9	3.66
Louisiana (Out)	+ 1/Manufacturing Shipments^2	96.9	14.80
Louisiana (Intra)	- Petroleum Production	91.2	-8.58
	06 - Petroleum Products		
Arkansas (In)	+ Manufacturing Shipments	93.0	9.68
Illinois (In)	- Petroleum Production	72.1	-4.37
Kentucky (In)	+ Manufacturing Shipments	93.8	9.70
Mississippi (In)	+ Petroleum Production	70.1	4.18
Ohio (In)	+ Time^2 - Time (log)	53.8	-1.67/2.77
Tennessee (In)	+ Petroleum Production	55.3	3.11
W. Virginia (In)	+ Petroleum Production	74.9	4.68
Louisiana (Intra)	+ Manufacturing Shipments	78.4	5.14
Mississippi (Intra)	+ Manufacturing Shipments	85.1	6.39
West Virginia (Intra)	+ Petroleum Production	79.5	5.30
	07 - Industrial Chemicals		
Alabama (In)	+ Manufacturing Shipments	88.8	7.51
Arkansas (In)	+ Manufacturing Shipments	51.1	2.88
Louisiana (In)	+ Chemical Production	88.5	7.43
Louisiana (Intra)	+ Chemical Production	73.9	4.56
	08 - Ag. Chemicals/Fertilizers		
Mississippi (Out)	+ Chemical Production	82.0	5.73
Mississippi (Intra)	+ Chemical Production	70.6	4.22
	09 - Milled Grain		
Illinois (In)	+ Fertilizer Consumption	76.7	4.90
	11 - Sugar and Molasses		
Ohio (In)	- Food Production	57.5	-3.24
	12 - Primary Metal Products		
Iowa (Out)	- Fabricated Metal Production	87.6	-7.09
Louisiana (Out)	+ Manufacturing Shipments	75.0	4.69

(continued)

Regressed Relationship		R^2	T-Ratio
13 - Fabricated Metal Products			
Kentucky (Out)	- Manufacturing Shipments	50.5	-2.85
Tennessee (Out)	- Manufacturing Shipments	68.3	-4.01
Louisiana (Intra)	+ Manufacturing Shipments	51.1	2.88
14 - Scrap Metals			
Kentucky (Out)	- Primary Metals	53.7	-3.02
W. Virginia (Out)	- Primary Metals	54.4	-3.06
15 - Construction Materials			
Alabama (In)	+ Housing Starts	79.3	5.27
Iowa (In)	- Manufacturing Shipments	78.7	-5.18
Missouri (In)	+ Housing Starts	53.6	3.02
Ohio (In)	+ Housing Starts	71.3	4.29
16 - Mining Products			
Louisiana (Out)	- Manufacturing Shipments	67.7	-3.96
Illinois (Intra)	- Food Production	72.9	-4.46
Louisiana (Intra)	+ Food Production	59.9	3.39
17 - Non-durable Goods			
Mississippi (Intra)	- Food Production	78.8	-5.20
18 - Durable Goods			
Kentucky (Out)	- Manufacturing Shipments	52.8	-2.97
19 - Waste Materials			
Alabama (Out)	+ Manufacturing Shipments	51.2	2.89
Louisiana (Out)	+ Manufacturing Shipments	60.9	3.39
Mississippi (Out)	- Manufacturing Shipments	73.0	-4.47
20 - Waterway Improvement Materials			
Iowa (In)	- Manufacturing Shipments	57.9	-3.26
Louisiana (In)	+ Manufacturing Shipments	90.1	8.06

The initialized 1976 trade value that formed the baseline for forecasts of non-regressable flows was calculated in a manner consistent with the Mid-America Ports Study requirements for terminal capacity analysis and facilities planning. This value emphasized trade in more recent years, by the use of weighting, so that facility requirements are determined with an increased emphasis on 1975 and 1976 activity.[4]

Exhibit 10 compares the 1976 historical trade flows and the 1976 initialized trade flows for all trade flows including those that were regressable or set to zero. Interstate traffic is understated by approximately 6 percent, and intrastate traffic is overstated by 5 percent. These discrepancies are reduced in the actual forecast because a significant share of the tonnage is forecast on the basis of the regressioned relationships which do not utilize the 1976 initialized values.

Exhibit 11 presents the designated directions and econometric factors utilized to project non-regressable flows. Regressable flows were forecast using proprietary regression/forecasting packages. Future non-regressable flows were developed on the basis of econometric growth applied to the 1976 initialized values.

[4]The multiplier weights applied to 1975 and 1976 were 2 and 3 respectively.

Exhibit 10

COMPARISON OF 1976 AND INITIALIZED 1976 TRADE FLOWS

Commodity Group	Interstate Inbound 1976 Actual	Interstate Inbound 1976 Initialized	Interstate Outbound 1976 Actual	Interstate Outbound 1976 Initialized
Cash Grains	41,545,601	31,361,132	40,871,318	31,737,748
Iron & Non-ferrous Ores	8,265,327	9,261,954	2,381,983	2,219,662
Bauxite and Aluminum Ores	384,899	418,909	418,905	437,882
Coal	59,822,915	54,212,518	71,733,787	68,589,787
Crude Petroleum	7,909,160	8,556,827	13,479,691	26,677,816
Petroleum Products	47,299,418	43,537,402	53,140,324	48,943,723
Industrial Chemicals	13,622,493	13,254,792	12,587,791	12,717,218
Ag. Chemicals/Fertilzers	12,290,506	10,618,480	5,524,655	4,701,790
Milled Grain	6,433,341	4,040,706	6,407,389	4,128,672
Lumber and Wood	829,940	774,732	858,585	789,827
Sugar and Molasses	1,062,634	1,152,491	1,086,910	1,085,086
Primary Metal Products	4,713,489	4,747,863	4,942,318	5,063,094
Fabricated Metal Products	282,645	333,198	307,176	375,432
Scrap Metals	733,398	634,818	1,308,265	827,865
Construction Materials	18,870,679	18,907,550	13,261,691	13,326,431
Mining Products	5,041,541	5,179,584	6,719,790	6,983,103
Non-Durable Manufactures	1,348,090	1,224,725	1,505,321	1,291,484
Durable Manufactures	575,013	411,930	711,852	512,047
Waste and Scrap	506,385	586,649	474,721	467,158
Waterway Improvement Materials	4,627,237	4,976,984	4,594,588	5,085,421

Total Interstate 1976 Actual - 478,481,771 tons
1976 Initialized - 450,154,491 tons -6%

Commodity Group	Intrastate 1976 Actual	Intrastate 1976 Initialized
Cash Grains	1,937,664	1,326,929
Iron & Non-ferrous Ores	4,017,485	3,073,749
Bauxite and Aluminum Ores	0	0
Coal	54,062,582	51,201,796
Crude Petroleum	18,488,179	22,717,356
Petroleum Products	15,994,077	12,287,890
Industrial Chemicals	6,613,861	7,535,088
Ag. Chemicals/Fertilizers	237,700	830,726
Milled Grain	833,519	766,324
Lumber and Wood	864,313	1,070,737
Sugar and Molasses	119,472	125,965
Primary Metal Products	625,170	1,120,020
Fabricated Metal Products	200,129	140,367
Scrap Metals	167,555	143,064
Construction Materials	22,920,710	24,650,771
Mining Products	8,488,692	9,374,080
Non-Durable Manufactures	583,874	360,898
Durable Manufactures	2,048,484	1,564,193
Waste and Scrap	4,675,946	5,009,938
Waterway Improvement Materials	2,686,661	3,325,645

Total Intrastate 1976 Actual - 145,566,073
1976 Initialized - 146,625,535 +5%

Exhibit 11

ECONOMETRICS UTILIZED FOR GROWTH RATES
APPLIED TO INITIALIZED 1976 COMMODITY MOVEMENTS

For All Non-Regressable Flows

Group	Commodity Group	Designated Interstate Direction[1] for all Forecasting	Econometric Factor[2]
01	Cash Grains	In	Grain Production
02	Metallic Ores	Out	Primary Metal Productions
03	Non-Metallic Ores	In	Primary Metal Production
04	Coal	Out	Coal Production (coal consumption intrastate)
05	Crude Petroleum	Out	Petroleum Production
06	Petroleum Products	In	Petroleum Production
07	Industrial Chemicals	In	Chemical Production
08	Ag. Chemical/Fertilizers	Out	Chemical Production
09	Milled Grain	In	Food Production
10	Lumber/Wood	Out	Lumber Production
11	Sugar/Molasses	In	Food Production
12	Primary Metals	Out	Primary Metal Production
13	Fabricated Metals	Out	Metal Fabrication
14	Scrap Metal	Out	Primary Metal Production
15	Construction Material	In	State Manufacturing
16	Mining Products	Out	State Manufacturing
17	Non-Durable Manufacture	In	State Manufacturing
18	Durable Manufacture	Out	State Manufacturing
19	Waste and Scrap	Out	State Manufacturing
20	Waterway Improvement Material	In	State Manufacturing

[1]Direction determined by response of regressible flows.

[2]Growth rates were determined on the basis of the log of the econometric regressed against time. The anti-log of the slope of this relationship is equivalent to the annual growth rate multiplier.

IV. DEVELOPMENT OF THE ORIGIN AND DESTINATION OF TRADE

A. STATE TO STATE TRADE ALLOCATION

At the state level, an allocation process was used to generate state-to-state movements. This allocation was based on trends in the historic patterns of commodity movements between state pairs. Depending upon whether the outbound or inbound movements of a commodity designated for interstate forecasting, this allocation determined the destinations of outbound interstate movements or the sources of interstate inbound movements.

This state-to-state allocation resulted in a mapping of 100 percent of the annual activity, with each partner state as a percentage of the state which was forecast. Exhibit 12 summarizes the process for allocating annual state-to-state commodity movements. The history of percentage distributions that results was forecast using rolling weighted averaging. As in the averaging of historical state-commodity directional flows, the most recent observation and that preceding it are weighted by 3 and 2, respectively. This averaging was performed annually in forecasting state-to-state percentages for the years 1977-2000. These percentages were then normalized to obtain final percentage distributions of future state-to-state commodity movements. Finally, 1980, 1985, 1990 and 2000 state-to-state distributions were applied to corresponding state forecast tonnages to obtain state-to-state tonnage forecasts.

B. SUBREGION-TO-SUBREGION TRADE ALLOCATION

Historical activity of both interstate and intrastate commodity movements at the subregion-to-subregion level were analyzed to develop distributions which were applied to the state pair movements to obtain subregion-to-subregion movements. The subregion-to-subregion allocation process is graphically shown in Exhibit 13. As in the case of state-to-state movements, a normalized rolling weighted average was employed to forecast future subregion-to-subregion movement distributions. The subregion-to-subregion allocation of commodity movements was then applied to the state-to-state forecast of commodity movements to provide a subregion-to-subregion base forecast of commodity movements for the Mid-America states.

Exhibit 12

MID-AMERICA PORTS STUDY

STATE-TO-STATE COMMODITY MOVEMENT ALLOCATION

For each commodity the percentage allocations were developed as follows:

$$C_{1-n}$$

$$Y_{1-m}$$

$$SS_{1-x} \text{ to } RS_{1-y}$$

Sending State	Receiving State
SS_1	RS_1
SS_2	RS_2
⋮	⋮
SS_x	RS_y

Movement	Volume[1]	Percentage
SS_1 to RS_1	$V_{1,1}$	$P_{1,1}$
SS_1 to RS_2	$V_{1,2}$	$P_{1,2}$
⋮	⋮	⋮
SS_1 to RSy	$V_{1,y}$	$P_{1,y}$
⋮	⋮	⋮
SS_x to RS_1	$V_{x,1}$	$P_{x,1}$
SS_x to RS_2	$V_{x,2}$	$P_{x,2}$
⋮	⋮	⋮
SS_x to RS_y	$V_{x,y}$	$P_{x,y}$

The percentage distribution for send states can therefore be expressed as:

$$P_{x,y} = \frac{V_{x,y}}{\sum_{y=1}^{y} V_{x,y}}$$

and for receive states as:

$$P_{x,y} = \frac{V_{x,y}}{\sum_{x=1}^{x} V_{x,y}}$$

Where: C = Commodity
Y = Year
SS = Sending State
RS = Receiving State
V = Commodity Movement Volume Between Two States
P = Percentage of Volume Moved Between Two States to the Total Moved Between Each State and All Other States.

[1] If x=y $SS_x = RS_y$; $V_{x,y} = 0$

Exhibit 13

MID-AMERICA PORTS STUDY

SUBREGION-TO-SUBREGION COMMODITY MOVEMENT ALLOCATIONS

For each commodity, year and state pair the percentage allocations were developed as follows:

$$C_{1-n}$$
$$Y_{1-m}$$
$$SS_{1-x} \quad \text{to} \quad RS_{1-y}$$

Send Subregion	Receive Subregion
SSR_1	RSR_1
SSR_2	RSR_2
⋮	⋮
SSR_i	RSR_j

Movement	Volume	Percentage
SSR_1 to RSR_1	$V_{1,1}$	$P_{1,1}$
SSR_1 to RSR_2	$V_{1,2}$	$P_{1,2}$
⋮	⋮	⋮
SSR_1 to RSR_j	$V_{1,j}$	$P_{1,j}$
SSR_2 to RSR_1	$V_{2,1}$	$P_{2,1}$
SSR_2 to RSR_2	$V_{2,2}$	$P_{2,2}$
⋮	⋮	⋮
SSR_2 to RSR_j	$V_{2,j}$	$P_{2,j}$
SSR_i to RSR_1	$V_{i,1}$	$P_{i,1}$
SSR_i to RSR_2	$V_{i,2}$	$P_{i,2}$
⋮	⋮	⋮
SSR_i to RSR_j	$V_{i,j}$	$P_{i,j}$

The percentage distribution of state pair traffic assigned to each subregion pair can therefore be expressed as:

$$P_{i,j} = \frac{V_{i,j}}{\sum_{i=1}^{i} \sum_{j=1}^{j} V_{i,j}}$$

Where: C = Commodity
Y = Year
SS = Sending State
RS = Receiving State
SSR = Sending State Subregion
RSR = Receiving State Subregion
V = Commodity Movement Volume Between Two Subregions
P = Percentage of Volume Moved Between Two Subregions to Total Moved Between Each State Pair.

V. REVISION OF PRELIMINARY BASELINE FORECAST

A. REVISION OBJECTIVE

The objective of the revision was to improve the overall quality of the forecast by systematic adjustment of the designated interstate and intrastate flows as necessary. In the preliminary forecast, all trade flows were forecast using forecast values of pertinent econometric variables that almost universally increased over time. Traffic was therefore expected to be overstated in the preliminary forecast. The overstatement was largely attributed to state/commodity flows forecast to increase, despite historical activity that would indicate a definite and absolute decline in waterborne activity. For this reason, the major thrust of the revisions were directed at the identification and adjustment of there divergent factors in the forecast.

B. COMPARISON OF PRELIMINARY FORECAST AND HISTORICAL FLOWS

The initial step in forecast revision was a comparison of historical compounded 1969-1976 to 1976-2000 and 1980-2000 preliminary forecast growth rates to identify commodity group performance which appeared inconsistent. Exhibit 14 presents the results of this comparison. The historical decline in 8 of the 20 commodity groups over this eight year period did not generate corresponding decreases in traffic during the forecast period. The rapid historical growths of cash grains, iron and nonferrous ores, agricultural chemicals and fertilizers, milled grains, scrap metals and durable and non-durable manufactures historically exhibited growth higher than those forecast.

Despite these apparent incongruities, the results of a commodity-by-commodity review identified several considerations that reinforced the generally moderate growth generated by the preliminary forecast. The results supported a revision methodology focusing on the adjustment of forecast flows on the basis of historical trends as discussed below:

Cash Grains--the 10.8 percent historical growth of this commodity group during the 1969-1976 period was related to the Russian Grain Deal of 1972, and subsequent exports to

Exhibit 14

COMPOUND GROWTH RATES
DESIGNATED DIRECTION AND INTERSTATE
(percent)

Group	Historical 1969-1976	Forecast 1976-2000	Forecast 1980-2000
01 Cash Grains	10.8	2.7	2.4
02 Iron and Nonferrous Ores	7.9	4.3	5.1
03 Bauxite & Aluminum Ores	--	4.6	4.2
04 Coal	2.0	1.5	1.3
05 Crude Petroleum	(10.0)	2.6	2.4
06 Petroleum Products	4.9	3.5	3.5
07 Industrial Chemicals	.8	5.6	5.3
08 Ag. Chemicals/Fertilizers	7.5	4.8	4.7
09 Milled Grain	16.2	3.3	2.7
10 Lumber & Wood	(.4)	6.5	5.8
11 Sugar & Molasses	(1.0)	4.3	4.0
12 Primary Metal Products	(1.1)	4.1	3.4
13 Fabricated Metal Products	(5.0)	3.8	3.8
14 Scrap Metals	10.9	2.2	4.3
15 Construction Materials	(.5)	4.4	4.2
16 Mining Products	(1.2)	1.3	1.2
17 Non-durable Manufactures	7.4	3.0	4.2
18 Durable Manufactures	6.2	2.7	4.0
19 Waste and Scrap	5.4	4.3	3.9
20 Wat. Improvement Mtls.	(.3)	6.3	5.2
Total	1.1	3.1	3.0

Source: Temple, Barker & Sloane, Inc.

other nations. During this period grain production expanded at only 3.5 percent per year.

The future growth of waterborne cash grain flows will be at a reduced rate. The Mid-America states grain output will expand at only 1.8 percent per year and national exports will increase at an annual rate of 2.6 percent. In addition, an increasing share of agricultural exports (and domestic waterborne trade) will be in the form of milled grains.

Milled Grains--which expanded at an annual rate of 16.2 percent, generally flowed to Louisiana and benefited from recent national export activity. The preliminary forecast generated 3.3 percent annual growth between 1976 and 2000. Agricultural exports will consist of large volumes of milled grains. Louisiana's receipts of milled grains were revised to comprise one-third of the state's cash grain receipts in 2000, yielding a 6 percent annual revised growth rate.

Lumber and Wood Products--the slight decline registered by this commodity group was due in part to a recent adjustment in trading patterns, with interstate traffic increasing at an annual rate of 11 percent and intrastate traffic decreasing. Currently equal in volume to interstate flows, interstate traffic will continue its growth in the future.

Primary Metals--in a manner similar to lumber products, interstate traffic registered an historical increase, while intrastate movements fell by 1.1 million tons in 1969 to .6 million in 1976. The production of metals in the Mid-America states will show a more than four-fold increase in annual growth during the forecast period, and growth in this commodity's waterborne traffic will also increase.

Fabricated Metals--which registered a 5 percent annual decline historically, are of such low volume (.3m tons interstate, 2 million tons intrastate) that the impact of the recession on the waterborne movement of fabricated metal products is large. Growth in this group during the forecast period may be expected.

Construction Materials--interstate movements increased through 1972, then fell while intrastate movements remained in the 18-21 million ton range. The majority of production is along the Ohio River, where shipments are made to destinations as close as just across the river, and as far away as Louisiana. The preliminary forecast over estimates the growth of this commodity by a wide margin.

Mining Materials--primarily salt and marine shells, the dominant interstate traffic has steadily declined, while intrastate traffic registered 5.1 percent growth during the 1969-1974 period. A lower growth rate would appear to be more consistent with this historical trend.

Waterway Improvement Materials--the movements of this commodity group are related to the development of new waterways and regular channel maintenance. The future of this commodity is not tied directly to the economic development of the region.

C. ADJUSTMENT OF SELECTED FLOWS

After general review of the preliminary forecast, an in-depth review of the nearly 800 interstate and intrastate flows was performed. Two guidelines were followed:

1. Flows with declining historical trade activity were regressed to determine the rate of annual decrease. This rate would be applied to the initialized 1976 value to generate revised forecast flows.

The underlying rationale behind this downward adjustment of flows was that a definite historical decrease in activity is the result of a combination of factors, not all economic in nature. Sources and availability, commodity life cycle, competitive modess, stockpiling and other procurement policies, produce substitution and other factors may have a dominant effect upon a commodity's waterborne trade activity.

Given the general upward trend of all econometric factors in the Mid-America region despite the recession that followed the oil embargo, declining flows were treated as distinct combination of events that would lead to a continued decrease in activity.

2. Flows whose regressions indicate no activity in 1980 were supplied with a "step" value for 1980. This value was equal to one-half the weighted average of the historical flows.

3. In a very few cases, flows forecast to increase were adjusted to continue to increase but at a rate more consistent with historical trends.

Exhibit 15 summarizes the flows that were revised. Nearly 68 flows were revised in all 20 commodity groups. Eight of these flows were flows formerly forecast by regression. Of these flows, 6 underwent only minor adjustment as a 1980 transitiion value was added. Twelve of the revised flows were adjusted to increase, 56 to decrease.

The overall impact of these adjustments proved to be relatively minor in impact on the total waterway system. The adjustments do add credibility to projected subregional and state level flows and recognize trends in declining waterway activity that are frequently overlooked.

Once revised, the forecast was rerun at the state/commodity/direction level on the CDC 6000 system. Exhibit 16 summarizes the comparative growth rates of the preliminary and revised forecasts. The lower overall growth rates, and adjustments to the twenty commodity groups can be seen. Notably, construction materials experience a down adjustment while coal, milled grains, and agricultural chemicals are projected to experience more rapid growth. Comparison of the historical trends of commodity group shares of system traffic and forecast values generally points to the increased validity of the baseline forecast, as shown in Exhibit 16.

Exhibit 15

FLOWS REVISED
TO HISTORICAL GROWTH RATES

01
Cash Grains
Illinois 1-
Iowa 1-
Kentucky 1-
*Missouri 3- 1980
Tennessee 1-

02
Iron and Nonferrous Ores
Tennessee 2-

03
Aluminum & Bauxite
Alabama 3-
Arkansas 1-

04
Coal
Ohio 2+
Ohio 3+
W. Virginia 3-

05
Crude Petroleum
Alabama 3-
Kentucky 2-
Kentucky 3-
Ohio 2

06
Petroleum Products
Alabama 1+
Louisiana 1+

07
Industrial Chemicals
Alabama 3-
Iowa 1-
Missouri 1-
Ohio 1-
Pennsylvania 1-
W. Virginia 1-
W. Virginia 3-

08
Ag. Chemicals/Fertilizer
*Illinois 3- 1980
Iowa 2-
Louisiana 2-
Ohio 2-

09
Milled Grain
Alabama 1-
*Louisaina-special adjustment +
Mississippi 3-
*Tennessee 1-

10
Lumber & Wood Products
Arkansas 2+
Kentucky 2-
Mississippi 2-
Mississippi 3-
Tennessee 3 1980

11
Sugar and Molasses
Missouri 1-
Pennsylvania 1-

12
Primary Metals
Alabama 2-
Alabama 3-
Kentucky 2+

13
Fabricated Metals
*Tennessee 2- 1980

14
Scrap Metals
Alabama 3+

15
Construction Materials
Arkansas 1+
Illinois 1-
Illinois 3-
Iowa 3-
Kentucky 1-
Kentucky 3-
Louisiana 3-
Mississippi 3-
Missouri 3-
Pennsylvania 1-
Pennsylvania 3-
Tennessee 1+
Tennessee 3-

16
Mining Products
Alabama 3-

17
Nondurable Manufactures
*Illinois 1- 1980
*Kentucky 1- 1980
*Nebraska 1- 1980

18
Durable Manufactures
Alabama 3-
Mississippi 3-

19
Waste & Scrap
Louisiana 3-
Tennessee 2-

20
Waterway Improvement Materials
Arkansas 1+
Arkansas 3-
Missouri 1-

Key to Exhibit 15

+ = flow forecast to increase in revised forecast
- = flow forecast to decrease in revised forecast
1 = interstate inbound flow (designated)
2 = interstate outbound flow (designated)
3 = intrastate flow
1980 = a 1980 value was added to flows with zero flows in all forecast years as a transition. 1980 value equals one-half of the weighted average of the historical 1969-1976 flows.
* = flow was originally regressed. When revised with a 1980 value, the regressed forecast remained intact, with a 1980 value added for transition.

Exhibit 16

COMPARATIVE COMPOUNDED ANNUAL GROWTH RATES

PRELIMINARY AND REVISED BASELINE FORECASTS*

	Growth					Percent Share of Total Trade			
	Historical 1969-1976	Preliminary 1976-2000	Revised 1976-2000	Preliminary 1980-2000	Revised 1980-2000	Historical 1969	Historical 1976	Forecast Preliminary 2000	Forecast Revised 2000
Cash Grains	10.8	2.7	2.3	2.4	2.3	5.9	11.2	10.2	10.8
Iron and Non-ferrous Ores	7.9	4.3	4.2	5.1	5.1	1.1	1.6	2.1	2.3
Bauxite and Aluminum Ores	--	4.6	(2.0)	4.2	(2.2)	0.0	.1	.1	--
Coal	2.0	1.5	2.3	1.3	2.2	30.6	32.3	22.0	28.9
Crude Petroleum	(10.0)	2.6	1.6	2.4	2.0	19.0	8.2	7.4	6.2
Petroleum Products	4.9	3.5	3.2	3.5	3.5	12.7	16.3	17.6	18.0
Industrial Chemicals	.8	5.6	3.8	5.3	3.9	5.3	5.2	9.1	6.6
Ag. Chemicals/Fertilizers	7.5	4.8	6.5	4.7	6.6	1.0	1.5	2.2	3.5
Milled Grain	16.2	3.3	5.7	2.7	5.3	.7	1.9	1.9	3.6
Lumber and Wood	(.4)	6.5	5.4	5.8	5.4	.5	.4	1.0	.8
Sugar & Molasses	(1.0)	4.3	3.5	4.0	3.4	.4	.3	.4	.4
Primary Metal Products	(1.1)	4.1	3.6	3.4	3.0	1.7	1.4	1.8	1.7
Fabricated Metal Products	(5.0)	3.8	3.8	3.8	3.8	.2	.1	.2	.2
Scrap Metals	10.9	2.2	2.2	4.3	4.3	.2	.4	.3	.3
Construction Materials	(.5)	4.4	1.8	4.2	2.0	12.1	10.7	14.2	8.5
Mining Products	(1.2)	1.3	.8	1.2	.7	4.6	3.9	2.5	2.4
Non-Durable Manufactures	7.4	3.0	3.0	4.2	4.1	.3	.5	.5	.5
Durable Manufactures	6.2	2.7	2.3	4.0	3.8	.5	.7	.6	.6
Waste and Scrap	5.4	4.3	2.5	3.9	2.4	1.0	1.3	1.7	1.2
Waterway Improvement Materials	(.3)	6.3	5.1	5.2	4.4	2.1	1.9	3.9	3.2
Total System	1.1	3.1	2.8	3.0	2.8	100.0	100.0	100.0	100.0

*Designated Direction and Intrastate

VI. DEVELOPMENT OF THE HIGH AND LOW ECONOMIC GROWTH SCENARIO FORECASTS

A. OBJECTIVE OF ECONOMIC SCENARIO FORECASTING

In order to determine an approximate range of future waterborne trade, the assumptions governing the basic economic development of the Mid-American Region were altered to encompass a likely range of trends in major determinants including inflation, capital investment, productivity and energy conservation.[5] Table 1 presents the most significant of these variations for the factors on which the baseline forecast was based:

TABLE 1

PRINCIPAL SCENARIO ASSUMPTION

Low Growth	Scenario	High Growth
High	Inflation	Low
Low	Capital Investment	High
Low	Productivity	High
Stringent	Pollution and Vehicle Emission Control	Limited

The econometric and demographic variables resulting from these variations were utilized to develope high and low economic growth forecasts in a manner very similar to the baseline scenario. The process required two main operations; adjustment of the econometrics that govern the trade forecast; and the generation of the forecast using these revised econometrics.

[5] The development of the actual econometric and demographic variables for the high and low scenarios is described in chapter 5.

B. ECONOMETRIC ADJUSTMENT

Chase Econometrics Associates, Inc., as Economic Consultant to the Mid-America Ports Study, developed econometric multipliers which described the effects of high and low rate of economic development in the Mid-America Region. Multipliers were prepared for each forecast year as shown in Exhibit 17.

The overall levels of manufacturing shipments and industrial value added were expected to attain levels 16.1 percent greater than and 10.3 percent less than the baseline forecast in the high and low economic growth scenarios respectively. Similar ranges for the agriculture and coal industries were developed. The many uncertainties related to national energy policy and the development of coal resource produced the largest scenario variances, approximately +-20 percent in 2000.

The multipliers were used to adjust the appropriate econometric variables. The econometrics were thus prepared for the generation of high and low forecasts.

C. FORECAST GENERATION

Thf revised baseline forecast was duplicated twice on the CDC 6000 system, each reproduction serving as the basis for one of the two scenarios. After duplication the econometric variables were revised as previously described. All regressible flows relationships were re-forecast using the revised econometric variables. All non-regressable flows were forecast on the basis of the growth rates of the revised econometric variables. Finally, those flows adjusted during the revision process to better reflect historical performance were revised by applying the industrial production multipliers. The resulting forecasts are compared in tabular form in Exhibit 18 and graphically in Exhibit 18a.

The databases containing the high and low forecasts on the CDC 6000 system were transferred to the Honeywell 6000 system, so that state-to-state and subregion-to-subregion allocations could be performed.

EXHIBIT 17

HIGH AND LOW ECONOMIC SCENARIO MULTIPLIERS
(percent)

Economic Variable	Scenario	Multiplier			
		1980	1985	1990	2000
Manufacturing Shipments, SIC20 (Food), SIC24 (Lumber), SIC28 (Chemicals), SIC29 (Petroleum), SIC33 (Primary Metals), SIC34 (Fabricated Metals).	High	+1.6	+4.4	+7.3	+16.1
	Low	-1.4	-3.8	-5.9	-10.3
Grain Production Fertilizer Consumption	High	+1.4	+3.8	-6.3	-11.5
	Low	-2.4	-6.3	-10.0	-17.1
Grain Exports	High	+1.6	+4.6	+7.6	+13.8
	Low	-3.0	-7.8	-12.2	-20.6
Coal Production and Consumption	High	+3.7	+7.6	+11.3	+18.9
	Low	-4.4	-8.9	-13.3	-22.2

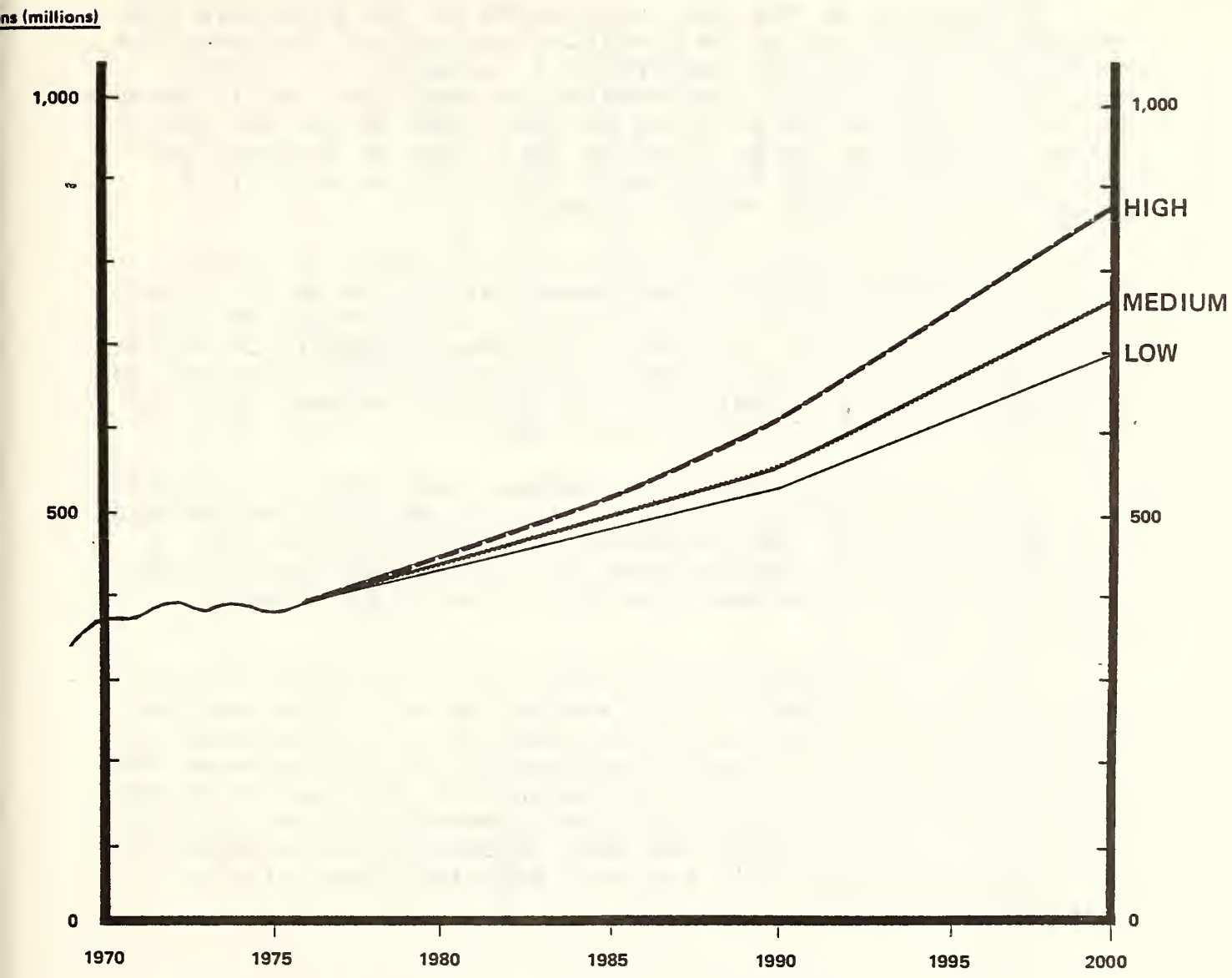
Exhibit 18

COMPARISON OF LOW, MIDDLE (BASELINE), AND HIGH SCENARIO FORECASTS

	LOW (percent below middle)	MIDDLE (Baseline) (1000 short tons)	HIGH (percent above middle)
1976	0.0	389,203	0.0
1980	-0.5	430,848	3.4
1985	-2.6	486,504	5.6
1990	-5.2	558,118	8.5
2000	-9.7	758,168	17.4
GROWTH RATE (Compound)	2.4	2.8%	3.5%

Exhibit 18a

COMPARISON OF HIGH, MEDIUM
AND LOW BASELINE FORECASTS



NOTE: Plot of designated direction interstate and interstate traffic.

VII. THE FORECASTING OF PROJECT TONNAGE

A. OBJECTIVE OF PROJECT FORECASTING

In addition to the many components of the waterways system which are currently in operation and respond to long-term trends in economics and demographics, a number of projects--newly completed, under construction or envisaged--will commence operations during the forecast period. The unique characteristics of these projects demanded that they be forecast separately so that their future activity could be accurately incorporated into the overall forecast.

The scope of work of the Mid-America Ports Study did not provide for the total development of forecasts of project tonnage, bur rather the identification of waterways projects and the incorporation of available tonnage forecats in a manner consistant with the overall trade forecast. Forecasts for all future projects identified are included in Army Corps of Engineers project feasibility analyses.

The forecasting of project tonnage was incorporated into the forecast in one of two ways: (1) project-related inbound or outbound tonnage was projected by commodity group and year; and (2) as project-related inbound and outbound tonnage where origins and destinations were forecast by commodity group and year.

Exhibit 19 presents an overview of the various projects identified for analysis, their status, scope and the general characteristics of project trade projects. The availability of Army Corps of Engineers prjections of project commerce was a major contribution to the development of Mid-America Ports Study Project Forecasts. The broad time-span in project life cycles of the projects in the same Exhibit 20 is accompanied by a range in the detail, accuracy and timeliness of the available forecasts.

Exhibit 19

MID-AMERICA PORT STUDY

WATERWAY PROJECT FORECASTS

Project Name	Project Status	Responding Army Corps District	Required Forecast Years	Forecast Reference	Forecast Type
Arkansas River	Operating	Little Rock District	1980, 1985, 1990, 2000	Temple, Barker & Sloane, Inc., (conversation with Oklahoma Port Authority	Origin and Destination of Cash Grains from Oklahoma
Kaskaskia River	24 Miles Completed	St. Louis District	1980, 1985, 1990, 2000	Evaluation of Total Waterborne Commerce, St. Louis District	Send or Recieve
Tennessee-Tombigbee Waterway	10 Miles Under Construction	Mobile District	1985, 1990 2000	Final Report--Evaluation of Transportation Economics, Tenn. Tom., Vol. 2.	Origin and Destination by Bureau of Economic Analysis Region
Red River-Mississippi River to Shreveport, LA	Authorized	New Orleans District	1985, 1990 2000	Red River Waterway Design Memo No. 2, Army Corps of Engineers	Send or Receive
Red River-Shreveport, LA to Dangerfield, TX	Authorized	New Orleans District	1990, 2000	Red River Wateway Design Memo No. 2, Army Corps of Engineers	Send or Receive
Yazoo River	Autorized	Vicksburg District	1990, 2000	Yazoo Projected Tonnage Memo, Vickburg District	Send or Receive
Cooza River	Authorized	Mobile District	1990, 2000	Restudy on Cooza River, Navigation Project, Mobile District.	Send or Receive

Note: The White River Project in Arkansas is an authorized expansion of an existing waterway and in its current status will likely preclude completion of the waterway during the forecast period. For this reason it was not included in their study.

Exhibit 20

ARKANSAS RIVER

OUTBOUND INTERSTATE CASH GRAIN MOVEMENTS

Year	Arkansas 042[a]	Arkansas 043[b]	Oklahoma 036[c]	Total River
1969	0	0	0	0
1970	55,376	15,776	0	71,152
1971	93,296	14,146	951	108,393
1972	119,345	19,958	7,009	146,312
1973	143,296	11,962	46,991	202,249
1974	167,764	12,238	150,849	330,851
1975	141,832	20,841	185,547	348,220
1976	195,262	29,625	211,780	436,667
1980	231,491	29,374	1,406,000	1,666,865
1985	268,430	35,181	3,080,006	3,383,611
1990	314,514	40,756	4,145,000	4,500,270
2000	379,328	49,142	5,614,000	6,042,470

[a]Mile 0 to 125.4 on the Arkansas River.

[b]Mile 125.4 to 308.5 on the Arkansas River.

[c]Mile 308.5 to head of navigation at Catoosa, Oklahoma.

Source: Temple, Barker & Sloane, Inc.

B. PROJECT FORECAST METHODOLOGY

Each forecast of project traffic required three basic steps: (1) a review of the primary project forecast currently available and the current prospects for and timing of its completion; (2) the translation of the available forecast into terms consistent with the Mid-America Ports Study forecast (subregion, direction, commodity group, and year); and (3) incorporation of the project forecast into the Mid-America Ports Study forecast.

Because each project forecast was based on projections prepared by different sources using different methods to achieve different objectives, the principal aspects of each forecast is outlined below:

1. Arkansas River--This waterway has undergone rapid growth in the years following its recent completion. Orginally designed for an annual capacity of 13 million tons, the Arkansas River handled more than 9 million tons in 1977. Planners are already investigating cost-effective shoreside winch assisted double-locking procedures that will increase waterway capacity. The requirement for channel widening is also under evaluation by the Army Corps of Engineers.

The most rapid growth has occurred in the formerly landlocked state of Oklahoma. Shipments of cash grains from Oklahoma are widely held to be the driving force behind rapid growth in Arkansas River traffic that is expected to continue into the future. This growth is largely due to changes in the collection of cash grains from the eastern half of Oklahoma and neighboring Kansas.

To address this recent development revised outbound cash grain flow projection for Oklahoma was prepared. This projection was based upon an ultimate capture by Olkahoma ports of 40 percent of the state's grain production and 12 percent of Kansas grain production. Combined with the less rapid growth of outbound cash grains from Arkansas, the total outbound cash grain movement could increase more than ten-fold by 2000 to approximately 6 million tons. Conversations with officials of the Port of Catoosa confirmed the reasonableness of these assumptions. Exhibit 20 presents the revised Oklahoma cash grain flows along with those of other Arkansas River subregions.

2. Kaskaskia River (Illinois)--This extension of the Kaskaskia River was treated as a project distinct from channel 30935 in Subregion 136, which handled 195,000 tons of cargo in 1975. The basis for this forecast was the Evaluation of Total

Waterborne Commerce Expected to Move on the Kaskaskia Navigation Canal and Associated Benefits, published in 1970 by the St. Louis District of the Army Corps of Engineers, Table 12. The tabular presentation of 1980, 1990, and 2,000 movements of three commodity groups was expanded to include 14 by allocating the "industrial" group to include a broad range of commodities handled by Illinois in the inbound, outbound and intrastate directions. The diverse industry the Kaskaskia River Basin will attract was the basis for performing this allocation. Exhibit 21 presents 2000 trade for the Kaskaskia by commodity group and direction.

3. Tennessee-Tombigbee Waterway (Alabama-Mississippi) --This waterway is currently under construction and when completed will be the only connecting waterway that is in "competition" with a parallel waterway, the Mississippi River. This competitive aspect posed the unique problem of identifying trade diverted from other points on the waterways system, notably the Port of New Orleans. The waterway is scheduled for completion between 1984 and 1986, depending upon the availability of Federal appropriations.

A highly detailed forecast was available for the Tennessee Tombigbee Project. The Mobile Districts Final Report, Evaluation of the Transportation Economics of the Tennessee Tombigbee Waterway, Volume II, Exhibit VI-8 presented 1986 trade-flow origin-destinations for commodity groups by Bureau of Economic Analysis Region (BEAR). Each commodity group and BEAR was translated into Mid-America categories. 1990 and 2000 flows were based on uniform growth towards projected total trade. Exhibit 22 presents 1986 trade through the waterway by commodity group.

4. Red River (both reaches Louisiana and Texas)--This waterway is scheduled to be completed in two stages and is the responsibility of the Army Corps of Engineers New Orleans District. The basic forecast resource available was the Red River Waterway General Design Memorandum No. 2, Phase I, Appendix M, "Report on Reanalysis of Project Benefits", Part I-Navigation Benefits. This report identified 9 basic commodity groups and discussed the nature of each one's trade on the Red River in detail sufficient for a consistent forecast to be prepared for both reaches of the waterway.

Exhibit 23 presents year 2000 projected trade for the Mississippi River-Shreveport and Shreveport-Diangerfield reaches of the Red River. The inbound movements of primary metal products, refined petroleum and non-durable manufactures is evident.

Exhibit 21

KASKASKIA RIVER PROJECT 2000 TRADE PROJECTION

		Inbound	Outbound	Intrastate
01	Cash Grains	0	1,600,000	0
02	Iron and Metallic Ores	306,900	0	0
04	Coal	0	11,005,300	5,694,700
05	Crude Petroleum	0	12,000	0
06	Petroleum Products	335,400	646,900	305,300
07	Industrial Chemicals	591,840	608,500	0
08	Ag.Chem/Fertilizer	372,600	15,834	0
09	Milled Grain	0	493,100	0
10	Lumber	19,700	0	0
11	Sugar and Molasses	61,400	0	0
12	Primary Metal Products	120,600	72,400	0
14	Fabricated Metal Products	28,500	11,300	9,100
15	Construction Materials	173,200	307,600	484,000
16	Mining Products	65,000	11,300	15,600
17	Non-Durable Manufacturers	0	27,100	0
19	Waste Material	17,500	11,310	415,500
20	Waterway Improvement Manufacturers	72,300	18,096	26,000

Source: U.S. Army Corps of Engineers, revised by Temple, Barker and Sloane, Inc. to align with the Mid-America Commodity groups.

Exhibit 22

TENNESSEE-TOMBIGBEE WATERWAY
1986 TRADE PROJECTION

		Alabama Mississippi Inbound	Alabama Mississippi Outbound	Alabama Mississippi Intrastate	Tenn-Tom. Throughbound
01	Cash Grains	345,339	0	541,457	0
02	Iron and Metallic Ores	559,363	2,522,051	155,620	0
04	Coal	20,282,557	0	4,228,505	4,646,047
06	Petroleum Products	357,965	197,598	165,432	0
07	Industrial Chemicals	1,064,858	1,201,430	170,660	65,288
08	Ag.Chem/Fertilizer	222,319	70,039	0	544,630
10	Lumber	0	0	89,213	0
12	Primary Metal Products	324,360	222,000	24,090	22,660
13	Fabricated Metal Products	198,550	0	84,142	0
15	Construction Materials	154,023	0	0	0
17	Non-Durable Manufacturers	15,212	1,281,623	59,345	116,468
18	Durable Manufacturers	285,386	0	114,091	0

Source: U.S. Army Corps of Engineers, revised by Temple, Barker and Sloane, Inc. to align with the Mid-America Commodity groups.

Exhibit 23

MID-AMERICA PORTS STUDY
RED RIVER PROJECTS

		Mississippi River to Shreveport, Louisiana			Shreveport, Louisiana to Diangerfield, Texas	
		Inbound	Outbound	Intrastate	Inbound	Outbound
01	Cash Grains	32,000	32,000	0	0	0
02	Iron and Metallic Ores	64,000	0	0	19,000	0
06	Petroleum Products	162,000	345,000	0	0	0
07	Industrial Chemicals	711,000	540,000	0	0	0
08	Ag.Chem/Fertilizer	20,000	0	0	0	0
08	Primary Metal Products	1,198,000	0	27,000	1,573,000	0
12	Fabricated Metal Products	112,000	0	62,000	0	0
14	Scrap Metals	0	62,000	0	0	96,000
15	Construction Materials	112,000	0	0	0	0
17	Non-Durable Manufactures	513,000	0	0	0	0
	Total	2,812,000	979,000	89,000	1,592,000	96,000

Source: U.S. Army Corps of Engineers, New Orleans District, revised by Temple, Barker & Sloane, Inc. to align with the Mid-America Commodity groups.

5. Yazoo River (Mississippi)--This development of this waterway is in the earliest stages of general design. The project forecast memo available from the Army Corps of engineers Vicksburg District provides 1989 (opening year) and 2039 flows for eight Mid-America commodity groups. These flows were interpolated for 1990 and 2000 values, and were assigned directions after conversations with Vicksburg District planning personnel. Exhibit 24 presents 2000 projected trade for the Yazoo River.

6. Coosa River (Alabama and Georgia)--This project is tentatively scheduled for operation by 1990, pending the results of ongoing analysis of its benefits to the region. The Army Corps of Engineers Mobile District prepared in 1977 Restudy on the Coosa River Navigation Project, Appendix B, a forecast of 12 Mid-American Commodity Group trade on Montgomery to Gadsden, Alabama and Gadsden to Rome, Georgia Reaches. Exhibit 25 presents 2000 projected trade on the Coosa River which is dominated by the intrastate movement of crude petroleum and construction materials.

Exhibit 24

MID-AMERICA PORTS STUDY

YAZOO RIVER PROJECT 2000 TRADE PROJECTION

	Commodity Group	Inbound	Outbound	Intrastate
01	Cash Grains	0	486,000	0
04	Coal	90,000	0	0
06	Petroleum Products	936,000	0	234,000
08	Ag.Chem./Fertilizer	836,000	418,000	0
09	Milled Grain	0	154,000	0
12	Primary Metal Products	64,000	0	0
15	Construction Materials	0	0	405,000
17	Non-Durable Manufacturers	0	152,000	0
	Total	1,926,000	1,192,000	639,000

Source: U.S. Army Corps of Engineers, Vicksburg District, expanded and revised by Temple, Barker & Sloane, Inc. to align with the Mid-America Commodity groups and forecast periods.

Exhibit 25

MID-AMERICA PORTS STUDY
COOSA RIVER PROJECT
2000 PROJECTION TRADE

	Commodity Group	Inbound	Outbound	Intrastate
02	Iron and Nonferrous Ores	0	0	0
05	Crude Petroleum	18,000	0	1,602,000
06	Petroleum Products	0	0	12,000
07	Industrial Chemicals	233,000	0	233,000
08	Ag/Chem/Fertilizer	0	0	10,000
11	Sugar and Molasses	0	0	18,000
12	Primary Metal Products	0	39,000	0
14	Scrap Metals	0	35,000	58,000
15	Construction Materials	0	0	2,310,000
16	Mining Products	12,000	0	0
17	Non-Durable Manufacturers	0	96,000	0
20	Waterway Improvement Manufacturers	0	0	235,000
	Total	263,000	170,000	4,478,000

Source: U.S. Army Corps of Engineers, Mobile District, revised by Temple, Barker & Sloane, Inc. to align with the Mid-America Commodity groups.

VIII. FORECAST OF WATERBORNE WESTERN COAL

A. AN OVERVIEW OF WESTERN COAL

The sharply increased imports and cost of petroleum following the 1973 oil embargo has caused the United States to develop energy policies that support the redevelopment of coal as a source of energy for future electric utility generation. The relatively mature coal fields of the Mid-America states have traditionally provided the coal necessary for domestic steam and metallurgical use and for export. The majority of coal has been consumed east of the Mississippi River, in proximity to traditional sources of coal.

In recent years, utilities within the Mid-America region have competed with eastern seabord customers and the requirements of exporters for an ever decreasing surplus of eastern coal. The consumption by the Mid-America states will exceed their total prodcution before 1980. This deficit in coal requirements must be met by the transportation of western coal into the Mid-America Region. Although western coal has only recently become a viable energy source, the implications of the availability of this low sulphur coal will be enormous in the future. Western coal is relatively low in heating value per ton, is easily recovered by surface mining technology, and much of its lies below shallow overburdens of soil. The high rates of productivity achievable more than compensate for the costs associated with western coal's lower Btu value and distance from consumers. It is for these reasons that a significant portion of western coal production will move into the Mid-America region and it is the purpose of this forecast to project the most likely demand for waterborne transportation of western coal.

B. DEMAND FOR WESTERN COAL BY THE MID-AMERICA REGION

As mentioned, the overall trend in coal demand by the Mid-America Region can be described as historical surplus through 1975-1980, followed by an increasing deficit thereafter. It is this deficit in coal supply that necessitates long-term commitments for western coal to augment supplies of higher heat content, eastern steam coal.

The majority of western coal will be delivered from the Powder River surface mines of southern Montana and northern Wyoming. Exhibit 26 presents a listing of commitments for Power River Coal by utilities with competitive access to barge transportation.

This near-term demand for western coal is perceived by the coal and rail industry to exceed supply. These commitments for western coal are in addition to the approximately 5 million tons of western coal delivered to consumers by barge and 18 million tons delivered by rail to utilities east of the Mississippi River in 1976. Exhibit 27 presents historical and forecast supply and demand for coal for the Mid-America Region. The implicit deficit of coal is understated due to flows by the Region to Atlantic and Gulf utilities and export facilities.

C. THE LOGISTICS OF WESTERN COAL FOR MID-AMERICA

The prospects for waterborne transportion of western coal are dependent upon the decision, policies and actions of the railroad industry. The Burnlington Northern Railroad (BN) and the Chicago and Northwestern Railroad (CNW) are the only major lines which serve the low cost sub-bituminous coal mined in the Powder River region of Montana and northern Wyoming. For reasons of cost and logistics, this coal offers the highest potential for movement eastward to the Mississippi River System. Coal from southern Wyoming, Colorado, and Utah will generally move by rail south to utilities in the Southwest. Some coal may move by all rail routes over the Union Pacific and Illinois Central to southern Alabama.

Of the two prime candidates, the BN is the most likely carrier of waterborn coal because of its capacity and the configuration of its northern lines. Seving both Montana and southern Wyoming, the GN will transport coal to the Lake Superior region and into the heart of the Mid-America Region. The BN has under cosntruction a 10 million ton per year rail-to-barge transhipment facility under construction in St. Louis scheduled for completion in 1979. Transhipment currently performed at Metropolis, Illinois. The CNW will haul lower volumes of coal to interchange points west of Superior for final delivery to the Great Lakes by connecting railroads. The operations of the CNW are not likely to have a significant impact on waterborne transportation.

Exhibit 26

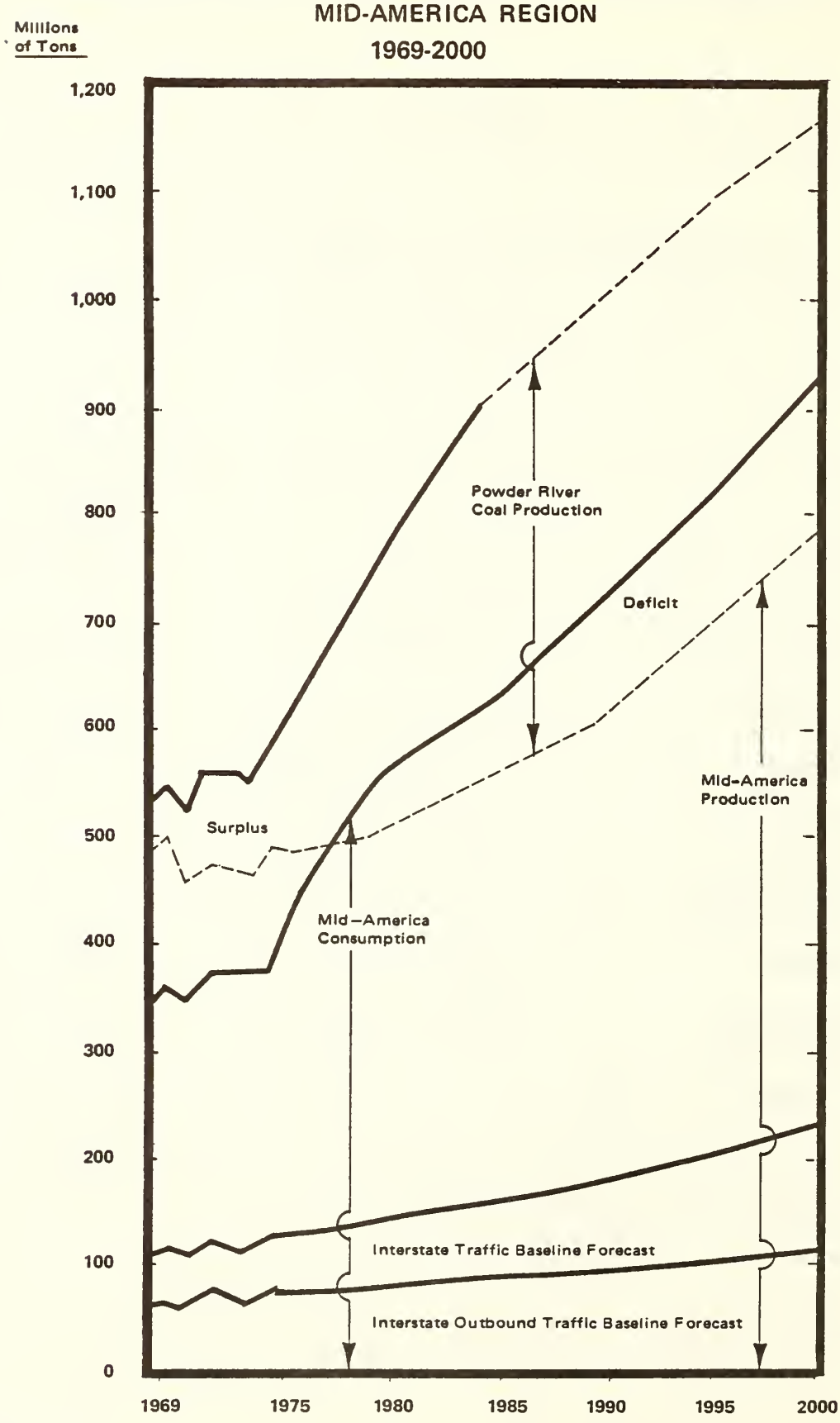
EXISTING COMMITMENTS BY UTILITIES WITH
COMPETITIVE ACCESS BY WATERWAY FOR POWER RIVER COAL
1980-1985
(Partial Listing)

Region Served	Utility	Tonnage Committed (millions)
Indiana, Ohio, West Virginia Illinois,	American Electric Power	10.0
Louisiana	Gulf State Utilities	2.5
Louisiana	Central Louisiana Power	1.0
Louisiana	Cajun Electric Power	4.0
Louisiana, Mississippi	Middle South Utilities	10.0
Arkansas	Arkansas Power & Light	5-10.0
Minnesota, Wisconsin	Northern States Power	8.4-13.4
Total Commitment		40.9-50.9

Source: Temple, Barker & Sloane, Inc.

Exhibit 27

HISTORICAL AND FORECAST COAL SUPPLY AND DEMAND
MID-AMERICA REGION
1969-2000



Source: Temple, Barker & Sloane, Inc.

The future transportation of western coal is therefore largely related to the demand for coal by waterside utilities in the Mid-America Region and the BN's plans for transshipment facilities to meet it. The BN had identified 3 major transshipment sites for future development: (1) Metropolis, Illinois (Ohio River); (2) St. Louis, Missouri (Lower Mississippi River); and (3) Minneapolis/St. Paul, Minnesota (Upper Mississippi River). Projected BN coal-hauling operations in 1985 are presented in Exhibit 28. The 1985 levels of transshipment are derived from analysis of various BN forecasts of coal traffic.

Transshipment operations by the BN will permit the railroad to extend economies of barge transportation and expand markets. Barging western coal to certain locations also avoids higher density mainlines and frequent railroad interchanges.

On the basis of published information and existing and projected demand, projected transshipment operations for BN coal at St. Louis, Metropolis and Minneapolis were developed. Exhibit 29 presents a summary of forecast activity by transshipment facility for the forecast period. Discussion with the Burlington Northern Railroad confirmed the validity of the assumptions upon which this projection is based. St. Louis, Missouri, and Metropolis, Illinois are predicted to become the leading facilities with nearly equal operations of 30 million tons annually in 2000. Minnesota will transship 12 million tons of western coal. The economies inherent in the movements of integrated flotilla of jumbo and even larger hopper barges of coal on the broad lower reaches of the Ohio and Mississippi Rivers with rapid discharge by 10,000 ton per hour continuous barge unloaders at waterside utilities are very large. The cost of this service is about one-third that of unit-train operations and absorbs the transshipment cost from rail to barge for destinations even short distances from the transshipment facility.

Transshipment projections to subregions were developed on the basis of current stated demand for western coal, and available capacity for transshipment. On the Ohio River destinations were weighted on the basis of 1990 demand for inbound steam coal. Exhibit 30 graphically present the BN's coal haul operations in relation to the transshipment operation in Mid-America and the implicit Mid-America deficit. By 2000 approximately one-third of BN's coal will be transshipped, an amount constituting approximately one-half of the region deficit. With existing commitments of the Mid-America to coastal utilities and other consumers, the 73 million tons transshipped to barges will represent about one-third of the deficit and this waterborne share of the transportation of coal is consistent with historical levels.

Exhibit 28

1985 BURLINGTON NORTHERN COAL-HAUL OPERATIONS
(All Purposes)
(millions of tons)

Destination	Purpose	Tons
Denver, Colorado	Rail Interchange & Local Consumption	33.0
Kansas City, Missouri	Rail Interchange & Local Consumption	30.0
Chicago, Illinois	Local Consumption	4.0
Peoria, Illinois[1]	Local Consumption	10.0
Superior, Wisconsin	Great Lakes Transshipment & Local Consumption	8.0
St. Louis, Missouri[2]	Local Consumption	5.0
Minneapolis, Minnesota	Local Consumption	10.0
Other Destinations	Rail Interchange & Local Consumption	9.0
---------- Future Rail/Barge Transshipment ----------		
St. Louis, Missouri	Barge Transshipment	16.0
Metropolis, Illinois[3]	Barge Transshipment	21.0
Minneapolis, Minnesota[4]	Barge Transshipment	3.0
Total Coal Transported	All Purposes	155.0

[1]The Burlington Northern interchanges with the Chicago & Illinois Midland for transshipment at Havana, Illinois on the Illinois waterway. 5 million tons of Montana coal is trans shipped at Havana for delivery by barge to Chicago utilities annually.

[2]St. Louis currently sends more than 3 million tons of western coal to other states by barge.

[3]Transshipment facilities at Metropois are in operation.

[4]Minnesota terminals handled 0.8 million tons of outbound interstate coal and 1.6 million tons of intrastate coal in 1976.

Source: Temple, Barker & Sloane, Inc.

Exhibit 29

FORECAST OF RAIL-TO-BARGE TRANSSHIPMENT
BY BURLINGTON NORTHERN RAILROAD[1]

(millions of tons)

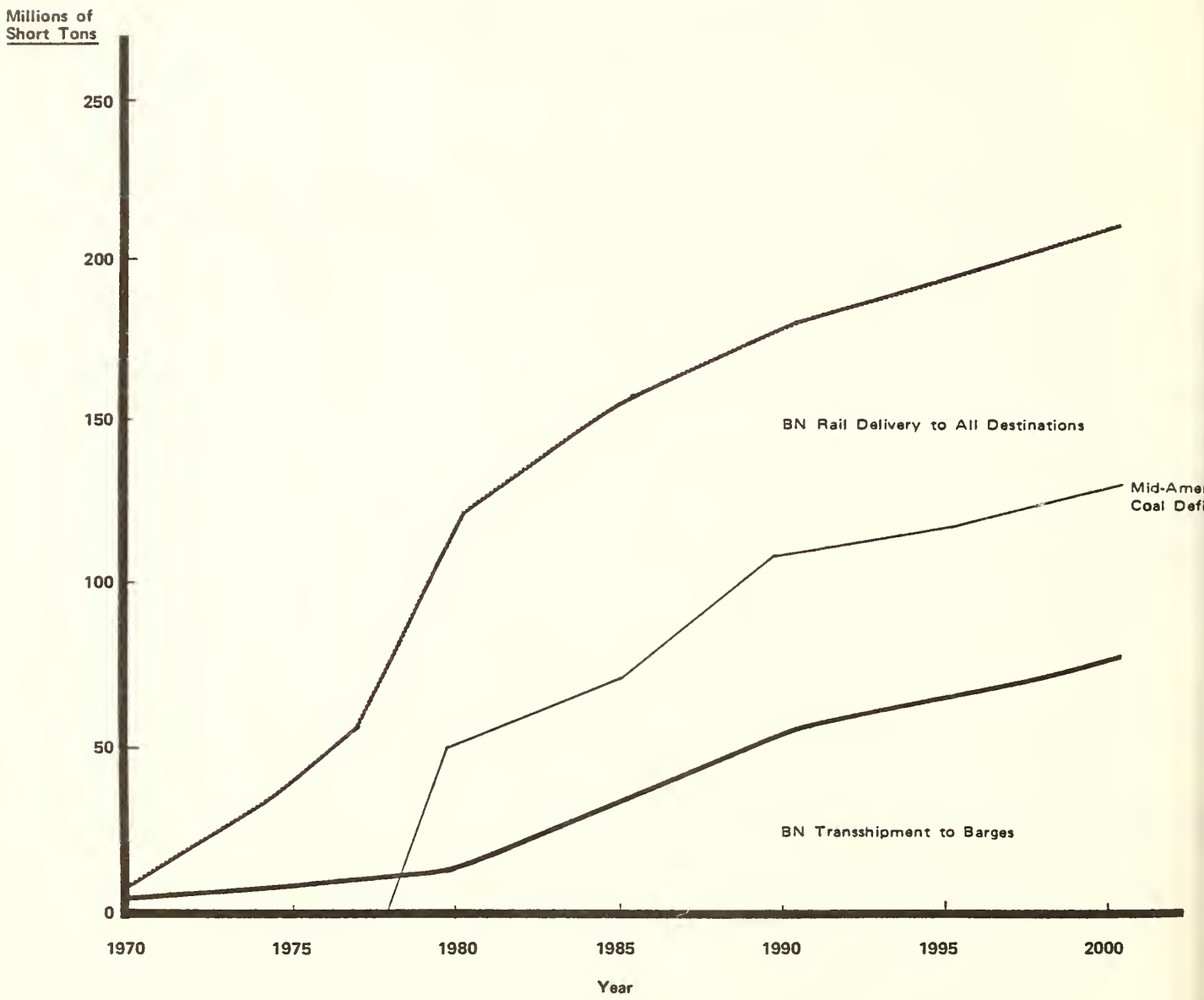
	St. Louis, Missouri Upper Mississippi to			Metropolis, Illinois Ohio River to			Minneapolis, Minnesota Lower Mississippi to			
Year	LM	UM	OH	LM	UM	OH	LM	UM	OH	Total
980	10	0	0	0	0	0	0	0	0	10.0
985	16	0	0	5	0	16	0	2	1	40.0
990	22	0	2	6	0	17	0	6	2	55.0
000	30	0	0	8	0	23	0	8	4	73.0
reas erved	AK MS LA GC			AK MS LA GC		TN ID KY OH WV		IO MI WI	TN ID KY OH WV	

ey LM = Lower Mississippi Destinations
UM = Upper Mississippi Destinations
OH = Ohio River Destinations
GC = Gulf Coast
Standard state abbreviations

ource: Temple, Barker & Sloane, Inc.estimates based upon analysis of published information and discussion with Burlington Northern Railroad.

Exhibit 30

FORECAST OF BURLINGTON NORTHERN RAILROAD
COAL DELIVERY AND TRANSSHIPMENT



Source: Temple, Barker & Sloane, Inc.

Efforts were made to maximize the impact on projections based from commitments by industry to supply or use western coal. These commitments by railroads and utilities can be seen as consensus of opinion with respect to the future of western coal and were accompanied by financial expenditures towards the realization of objectives. This analysis led to transshipment, and rail haulage levels for a new energy resource that are consistent with the experience of the past.

IX. LOCK DEMAND AND DIVERSION FORECASTING-FLOWS PAST A POINT

A. OBJECTIVE

In order to support Mid-America ports Study analysis of lock constraints along the inland waterways, a methodology to determine histoircal and forecast flows past points was developed. In addition, procedures to divert any traffic demand in excess of lock capacity were developed. These efforts were separate from various studies of capacities of specific locks on the waterway network and may be applied to any waterway constriction.

B. FLOWS PAST A POINT

The determination of flows past a point was done through mapping of subregion-to-subregion trade. Flows past a point must pass from one set of subregions to another set, the boundary being the point under study. By specifying all those regions in either set, any flow to the subject set from any unspecified subregion, or from the subject set to any unspecified subregion had to pass by the point under study. Flows between subregions in the specified set or between subregions in the unspecified set do not pass by the point. Locks were therefore identified by specifying the relatively few "upstream" subregions.

Analysis was performed for all locks identified as possible constraints by TAMS. Exhibit 31 presents a tabulation of the subregions assined to the "upriver" set for each lock.

Two aspects of this analysis should be noted:

- Locks located along a subregion (and not at a junction between subregions) were of necessity "sited" above or below that subregion on the basis of whether the majority of tonnage within the subregion was sent and received above or below the lock.

Exhibit 31

LOCK SUBREGIONS

Lock/Dam	At	Listed	Assigned Subregions/Comments	
Lock and Dam 26 Mississippi River (73 million) est.	257/132	Above	232 491 133 231 151 134 492 131 135 152 541	
Gallipolis L/D Ohio River Mile 702 (47 million)	352/482	Above	481 484 382 483 485 383 353 381 352 354	95% of 351 is above lock.
Kentucky L/D Tennessee River (31 million)	178	Above	178 425 423 426 015	
Lockport L/D Illinois Waterway (33 million)	135	Above	135 541	
Brandon Road L/D Illinois Waterway (32 million)	134	Above	135 541	52% above lock.
Dresden Island L/D Illinois Waterway (25.4 million)	134	Above	135 541	
Marseilles L/D Illinois Waterway (32 million)	134	Above	134 135 541	73% of 134 above lock.
Starved Rock L/D Illinois Waterway (36 million)	134	Above	134 135 541	73%+ of 134 above lock.
Peoria L/D Illinois Waterway (57 million)	133/134	Above	134 135 541	100% of 134 above lock.
LaGrange L/D Illinois Waterway (59 million)		Above	133 135 134 541	88% of 153 1975 tons above lock.
Inner Harbor Lock New Orleans, Louisiana (30 million)	182	Above	011 244	
Vermilion Lock Louisiana (45 million)	181	Above	181	
Port Allen-Morgan City Canal Locks, Louisiana (30 million)	186	Above	186	

- For those locks serving multi-accessed sub-regions (such as the Gulf Intercoastal waterway, Inner Harbor canal and Port Allen-Morgan City canals), it was not possible to determine the historical or projected use of a lock by this methodology. Traffic into and out of the sub-region containing the subject lock was therefore reported.

C. DIVERSION OF EXCESS DEMAND

When the demand for a lock exceeds its capacity, cargo will generally incur delays in passage and ultimately be diverted to alternative modes of transport capable of moving it in a more economic and/or timely manner.

The underlying principle for the determination of diversion of traffic from constrained locks is that higher value goods will generally incur higher inventory costs during delays, have transportation costs that are a smaller portion of their total value, move in smaller more easily re-routed lot sizes, are subject to less institutional transportation momentum, and can be more easily diverted to and absorbed by alternative transportation modes. Exhibit 32 compares graphically value per ton and percent share of waterborne traffic for the 20 Mid-America Commodity Groups. The generally inverse trend is evident as well as the relationship between value per ton and the share of waterborne traffic which was used as a surrogate.

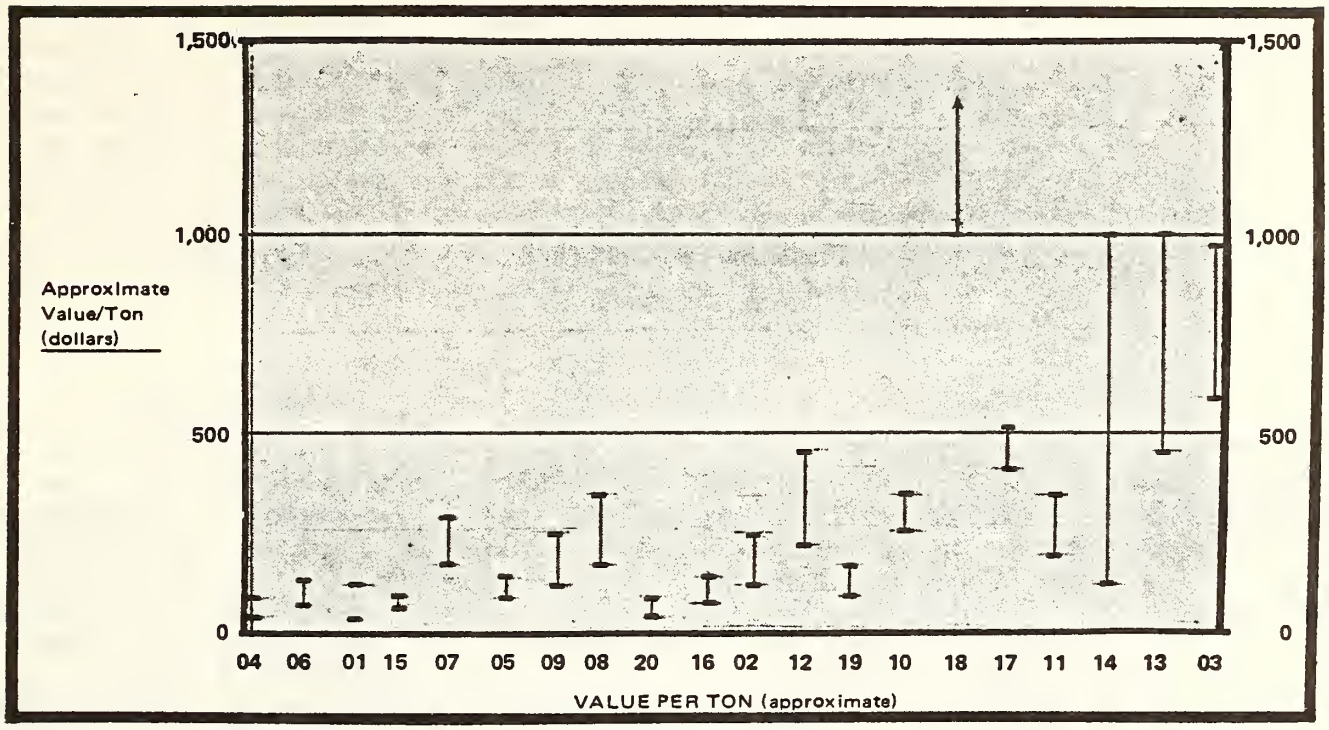
The diversion of traffic was based on four sets of commodity groups ranked by share of traffic relating to the susceptibility to diversion. Exhibit 33 depicts the composition of these four groups and the characteristics of their diversion.

D. DETERMINATION OF CONSTRAINED LOCK PERFORMANCE

A methodology for profiling the performance of lock under conditions of overdemand was developed which addresses diversion, relief, and recaption of diverted cargo. Locks in this condition were projected to be constrained at their capacity a period of ten years in the high forecast, 15 years in the mdeium forecast and throughout the forecast period in the low forecast. Following the period of constraint, the lock would

Exhibit 32

COMPARISON OF COMMODITY GROUP VALUE AND SHARE OF WATERBORNE TRAFFIC



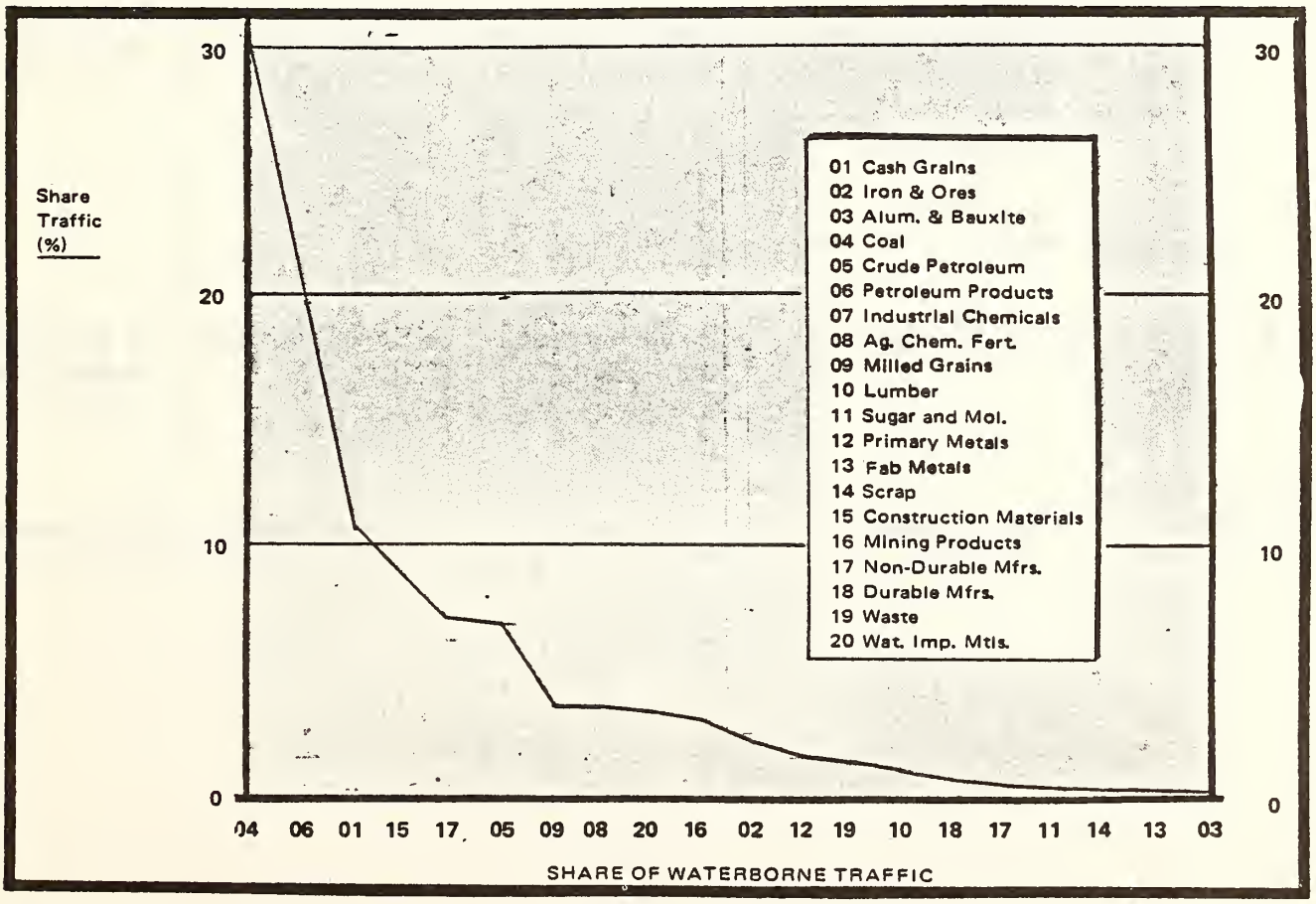


Exhibit 33

DIVERSION OF TRAFFIC
Commodity Sets

Relative Sensitivity	High Diversion	Medium-High Diversion	Medium-Low Diversion	Low Diversion
Commodity Group	02 Iron and Metal Ores 03 Alum. and Baux. 10 Lumber 11 Sugar and Molasses 12 Primary Metals 13 Fabricated Metals 14 Scrap Metals 17 Non-Durable Mfrs. 18 Durable Mfrs. 19 Waste	08 Ag. Chem/Fert. 09 Milled Grains 16 Mining Products 20 Wat. Imp. Mtls.	05 Crude Petroleum 07 Industrial Chemicals 15 Construction Materials	01 Cash Grains 04 Coal 06 Petroleum Products
Maximum Diversion	Up to 75 Percent	Up to 50 Percent	Up to 25 Percent	As necessary to meet lock capacity
Share of System Traffic	8.6 Percent	12.5 Percent	21.4 Percent	57.5 Percent

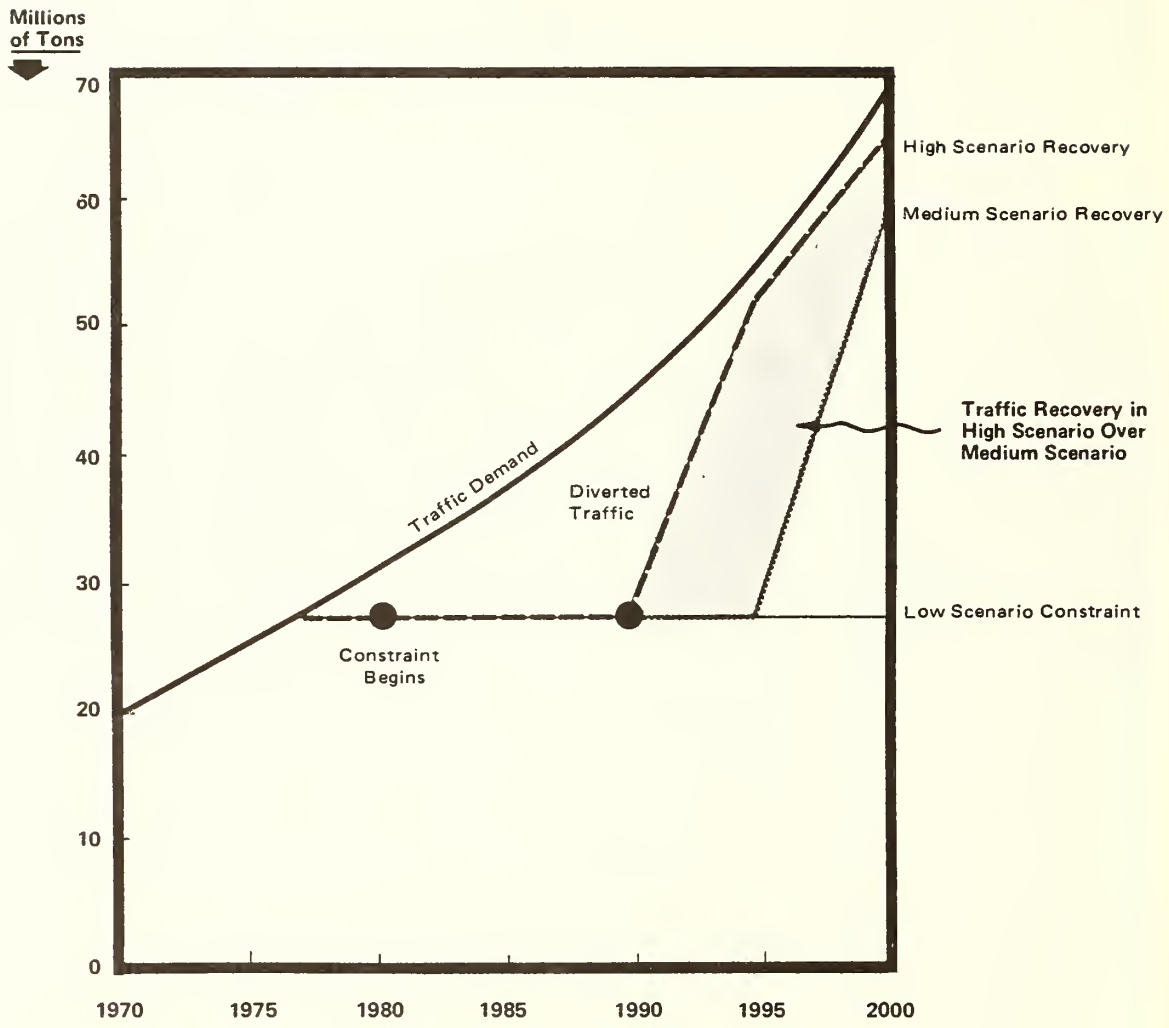
recover by the next forecast period 95 percent of the diverted tonnage in the high forecast or 75 percent of the diverted tonnage in the medium forecast. Exhibit 34 graphically presents the major components of congested lock performance. All diverted tonnage is composed of upbound and downbound cargo in proportion to their unconstrained flows past the lock. The diverted cargo, allocated by commodity, and subregional pair on a proportional basis, is then subtracted from subregional pairs flows.

E. SUMMARY

The operation of locks vital to domestic commerce operating under conditions of severe overdemand are a recent challenge facing the nation. Still in the early phases of congestion, the reactions of shippers to the lengthy delay of goods in transit are not yet clear. The methodology adopted for the Mid-America Ports Study is designed to be conceptually consistent with expected shipper reactions to congestion, yet applicable systemwide. The time periods during which locks are constrained and then recover portions of their trade are realistic and valuable to analysis of the operations of the waterways system. Project lock performance in the forecast is separated from the various policy issues that currently dominate national waterways policy and legislation.

Exhibit 34

COMPONENTS OF CONSTRAINED
LOCK PERFORMANCE COMPONENTS



Note: Only the medium scenario traffic demand line is shown.

X. LIMITATIONS AND AREAS FOR FUTURE IMPROVEMENT IN THE DATABASE AND FORECAST METHODOLOGY

A. OVERVIEW

The Mid-America Ports Study represents a major step forward in national domestic transportation planning. As one of its components, the forecast played a vital suporting role during the project but was not the primary objective of the study. However, each step of the methodology has direct appliability to the analysis of coastal, river, Great Lakes and inter-territorial domestic navigation. This applicability has already been realized in a number of studies with diverse objectives.

B. LIMITATIONS

1. Historical Time Span

Given the many precedents established in this effort, it is important to identify the limitations which may be addressed and hopefully avoided in future efforts. It is most important to appreciate the limitations of projecting twenty-five years of freight traffic on the basis of eight years of historical data. Because the Army Corps of Engineers has collected and maintained data for many years, in several forms, it is theoretically possible to load, analyze, and translate into a consistent format the trade of years prior to 1969. It would be far more efficient to continue to incorporate future years into the database, and given the significance of recent trends in transportation, far more worthwhile.

Many developments of long-term economic and industrial significance occurred during the 1969-1976 period. The recession that followed the Oil Embargo of 1973 and the four-fold increase in the cost of petroleum severely upset long-term business investment and all industries related to it. The rapid increase in petroleum importation, largely to deep

draft ports in the U.S. Gulf, countered the peaking and subsequent decline in absolute levels of on- and offshore U.S. oil production. The development of long-term grain export obligations to the Soviet Union and other nations greatly increased cash grain and milled grain shipments to Lower Mississippi River terminals. Advancements in electric furnace technology permitted the expansion of the steel industry in diverse Mid-America locations. Lastly, the initial movement of western coal from several transshipment sites opened yet another pattern of waterborne commerce that will evolve into significant future flows.

Each of these factors merits extensive in-depth analysis. Several factors warrant examination in the near future, and high returns in the precision and confidence of the resulting conclusion can be expected. Other factors, notably the transportation of western coal, are dependent upon the development of national energy policy, followed by commitment to it by utilties, industry and the railroads. The most notable absence of published projections was in the area of western coal transportation.

There are other developments in waterborne transportation that must be addressed in a similar manner. The utilization and production of chemicals to support the continued industrial development of all sectors of the Mid-America Region and the intensive agribusiness industry have potentially large impacts on the waterways. The importation of iron and non-ferrous ores, manganese and steel products are contingent upon the resolution of many challenges facing the U.S. steel industry. Trends in the consumption of coal by industry also warrant in-depth analysis as it becomes possible to translate demand into waterborne transportation patterns.

2. Economic and Non-Economic Forces

The methodology of the Mid-America Ports Study forecast sought to identify meaningful relationships between historical econometrics and historical trade. It did not seek high R^2 at the expense of any rational explanation of the relationship. While the methodology was generally successful, it was recognized from the outset that the waterborne traffic of many commodity groups would not respond to econometrics. As discussed, many commodity groups have values, logistical patterns, volumes, and lot sizes that dominate the development of their industrial parent or their market.

The assumption that such commodities will react to the performance of any econometric has great validity in general (as shown at the outset of this Appendix in Exhibit 1). For any specific commodity, particularly those of high value, low volume and low waterborne share, the correlation is less assured.

As opposed to the high volume movements of energy, agricultural and construction bulk commodities through large, integrated, private facilities, higher value cargos with wide-ranging characteristics and handling requirements move through public and private general cargo terminals. These facilities are far more dependent upon the preference of large numbers of shippers and consignees for waterways transportation. These shippers and consignees are in turn less dependent upon the waterborne transportation infrastructure and percieve of a variety of modal solutions to their transportation problems. This compounds the difficulty of determining waterborne trade and emphasizes the validity of using historical trade as the basis for such projections. In this respect the methodology represents a major step towards assisting public and private general cargo facility planners.

C. AREAS FOR FUTURE DEVELOPMENT

The opportunities for further development are of two types: those directly resulting from this forecast; and, the analysis of various types of transportation issues.

From the efforts of this project several analyses resulting from this study are possible. Major opportunities include:

- Preparation of an historical and forecast trade database determining ton-miles of transportation. This analysis will identify trends in the utilization of waterways, and the fleet required to meet its demand revenue base. Equipment requirements and the composition of the fleet can be fleet determined. This in turn would permit the future financial performance of the towing and barge industry to be assessed.

- Lock and Dam analysis. With adjustments to the database, additional subregional delineations can be placed at locks and dams. This refinement will increase the accuracy of lock perfor-

mance projections. The possibility of matching loaded barges with backhaul cargoes will produce forecasts of empty barge demand for lock capacity.

In addition to the opportunities that result directly from the Mid-America Ports Study Forecast, many new opportunities for the improved analysis of domestic waterborne commerce and its interface with competing transport modes and international shipping are at hand. Among these are:

- Port traffic analysis and forecasting. Coded channels combined to form ports can now be utilized to examine the flows, vessel commodities and origin/destinations of historical and forecast domestic cargo. Interaction between domestic and foreign traffic can be identified by individual marine terminal if necessary. Port interests can identify their waterborne hinterlands with a new accuracy and precision, thus enhancing their marketing opportunities.

- Competitive modal analysis. Flows of oil, coal, grain and other bulk commodities can be identified and opportunities for modal interchange can be studied.

- The relatively aged domestic fleet of the United States and its replacement requirements can be compared to forecasts of future domestic coastal trade. Lot sizes, origins and destinations can be used to determine technologies suitable for domestic marine transportation in the future.

The Mid-Amerca Ports Study forecast emerged as a valuable product in its own right with clear utility to both government and the private sector. As the foundation of a new and continuing capability in domestic waterborne analysis and forecasting, it has served a second and significant function.

MID-AMERICA PORTS STUDY

APPENDIX F

INTERSTATE COMPACTS IN MID-AMERICA AND PROCEDURES GOVERNING CIVIL WORKS PROJECTS

INTERSTATE COMPACTS IN MID-AMERICA

Two interstate compacts support riverport development in Mid-America. They are associated with the Port of Metropolitan St. Louis and the Tennessee-Tombigbee Waterway. Neither of these arrangements may be directly replicable because of the special circumstances associated with them. However, both represent a body of experience with interstate cooperation for port development that may be instructive to others who wish to maximize the benefits of interstate cooperation.

Port of Metropolitan St. Louis

The Bi-State Development Agency was established as a body corporate and politic by a compact between the states of Missouri and Illinois, which was approved by the Congress in 1950. The compact created a Bi-State Metropolitan District embracing the City of St. Louis and the counties of St. Louis, St. Charles and Jefferson in Missouri and the counties of St. Clair, Madison, and Monroe in Illinois. The Agency is governed by ten commissioners, five of whom are appointed by the governor of Missouri and five by the governor of Illinois. All are residents of the district.

The Bi-State Development Agency is empowered to plan, construct, maintain, own, and operate certain types of facilities, including bridges, tunnels, airports, wharves,

docks, grain elevators, and terminal facilities of all types. It also has authority to make studies and plans for submission to the communities involved for coordination of streets, highways, parkways, parking areas, terminals, water supply, and sewerage, recreational facilities, land-use patterns and other matters in which joint or coordinated action of communities within the district will be beneficial. Although the Agency has no taxing power, it may charge and collect fees for use of its facilities. It may issue bonds secured by revenues derived from its facilities or by the Agency's property. It may receive contributions, grants or other monies from municipalities, counties, states or the federal government. The Agency has been self-supporting since 1954.

From inception of the compact in 1949 until the East-West Gateway Coordinating Council was created in 1965, the Bi-State Development Agency served as the general planning agency for the metropolitan district. The compact provides that the Agency make plans for development of the district and a master plan for this was prepared and submitted to the two legislatures in 1951.

Subsequently the Agency helped to create a new regional planning body, working with the two state highway departments and others to set up a planning mechanism for complying with the Federal Aid Highway Act of 1962.

The Bi-State Development Agency is the lead organization for integrating and coordinating development of the Port of Metropolitan St. Louis. Its activities can go considerably beyond coordination of planning efforts for the constituent port authorities. For example, after a detailed study of the need for additional harbor facilities in the St. Louis metropolitan area, the Bi-State Development Agency leased a tract of land from the U.S. government for development of wharf and terminal facilities at Granite City, Illinois. Using proceeds of a $1.5 million revenue bond issue, the Agency constructed a dock and warehouse with rail and highway access in 1956. Later it extended the dock, installed a dry-bulk commodity unloading facility, and constructed a climate controlled warehouse. In 1975 the Agency sold the wharf and terminal facilities at the Granite City Harbor to the Tri-City Regional Port District for $730,000, toward which the Port District will pay $73,000 annually for a period of ten years.

Tennessee-Tombigbee Waterway

The Tennessee-Tombigbee Waterway project has been a concern of the federal government and participating states for several decades. When completed, the waterway will extend from the Pickwick pool on the Tennessee River southward through Mississippi and Alabama where the Black Warrior and Tombigbee Rivers converge at Demopolis, Alabama. It requires construction of six dams and eleven locks and a 27-mile canal

to join the natural waterways. Estimated federal investments approximate $1.8 billion. The Corps of Engineers will provide a navigation channel nine feet deep in the shallowest portion. Construction began in 1972.

The Tennessee-Tombigbee project has always been characterized by strong political sponsorship. Senator John Stennis of Mississippi referred to it as "the greatest economic milestone since the Louisiana Purchase" and gave it commensurate support. Governor George Wallace of Alabama said, "I'll do everything in my power to see that this worthwhile project is carried through to the finish". Although President Carter's 1977 review of the budget prepared by the previous administration called for "serious reexamination" of this project along with others, subsequent reviews endorsed the project.

Development of the waterway is promoted and coordinated by the Tennessee-Tombigbee Waterway Development Authority under an interstate compact to which Alabama, Mississippi, Tennessee, Kentucky and Florida adhere. Congress approved the compact in 1958. The authority has thirty members, divided equally among the participating states. Each state is represented by its governor and five citizens appointed by the governor. Chairmanship rotates annually among participating states.

The federal government's participation in the Tennessee-Tombigbee projects is contingent on appropriate action by local

sponsors with respect to highways, bridges, sewers, water supply systems, drainage facilities, and riverport terminals. Both Alabama and Mississippi are responding to these requirements. The 1962 session of the Mississippi legislature authorized formation of the Tombigbee River Valley Waterway Management District and gave it the powers necessary to fulfill local requirements for the Mississippi portion of the project. During its 1967 session the Alabama legislature authorized creation of a public corporation called the Tombigbee Valley Development Authority for the purpose of developing the Tombigbee River and its tributary streams. In December 1967 Alabama voters approved a $10 million bond issue to finance participation in the interstate undertaking and Alabama's associated projects.

The 1975 Alabama legislature authorized issuance of up to $45 million in general obligation bonds to finance improvements to state-owned facilities at the Port of Mobile. The law was signed by the governor on March 10, 1975, and approved by the voters as a constitutional measure in an election later in the year. A public corporation called the Alabama Port Authority acts as the state agency for issuing and selling the bonds and for approving disbursement of the proceeds. This Authority consists of the governor, the director of finance, one member of the Alabama Senate, one

member of the House of Representatives, and the director of the State Docks Department.

The Legislature's intent with respect to the uses to which the bond proceeds are to be directed is stated as follows:

> . . . to the extent deemed feasible in the sole discretion of Alabama State Docks Department, with approval of the Alabama Ports Authority, the proceeds of said bonds will be used in preparation for and in anticipation of the demands that will be made upon, and the opportunities that will be available to the Department as a result of the opening of the Tennessee-Tombigbee Waterway System.

During 1976 the Alabama Port Authority sold its first issue of $15 million in general obligation bonds. The proceeds of that issue are being used to expand container facilities and make other improvements at the Port of Mobile, including a new general cargo berth, additional warehouse space, electrical system improvements, installation of dust control systems in grain handling facilities and modernization of bulk materials handling systems.

At this writing the federal project (construction of the waterway itself) is the subject of a challenge in the federal

courts. A coalition of railroad and environmental interests brought suit against the Corps of Engineers, arguing that the project as constructed is exceeding authorized specifications.

Meanwhile, the project's continuing construction requirements are set forth in the Administration's F.Y. 1980 budget.

PROCEDURES GOVERNING CIVIL WORKS PROJECTS

Waterway development projects are initiated by local interests, authorized by the Congress, and constructed by the U.S. Army Corps of Engineers under its Civil Works Program. State and local officials interviewed in the course of the study all recognized that the Corps performs a vital role in waterway development. The following summary recapitulates step-by-step development of a typical Corps project on the inland waterways of the United States.

1. Local interests identify a need for improved navigation, flood protection, or other resource development.
2. Citizens and local government officials may petition their representatives in the Congress.
3. A Congressional committee (or an Act of Congress) may then authorize the Corps of Engineers to investigate the problem and submit a report.
4. The Chief of Engineers assigns the investigation to the appropriate Division Engineer who refers it to the District Engineer for the area to be studied.
5. When study funds are appropriated by the Congress and released to the District, the District Engineer

works closely with local authorities and other federal agencies in performing the required engineering, economic and environmental studies (which include consideration of a range of alternative solutions to the problem under study).

6. Public meetings are held to obtain the views of local interests on the type and extent of improvement needed.
7. The District Engineer submits his report and a draft environmental statement to the Division Engineer, who reviews them, adds his recommendations (if any), and forwards them to the Chief of Engineers.
8. The report and the associated environmental impact statement are referred to the appropriate review agency, as follows:
   a. The Board of Engineers for Rivers and Harbors reviews the report if it relates to work outside the alluvial valley of the Mississippi River.
   b. The Mississippi River Commission serves as the review agency on all work pertaining to the alluvial valley of the Mississippi River.
9. After the review agency submits its report and recommendations to the Chief of Engineers, he

coordinates it with other federal agencies, the Council on Environmental Quality, and Governors of the affected states.

10. After considering the views so collected, the Chief of Engineers sends the report and the final environmental impact statement to the Secretary of the Army, who obtains the views of the Office of Management and Budget before sending them to the Congress.
11. If the report recommends a project the Congress may include it in an authorization bill, which if enacted into law constitutes official authorization of the project.
12. The Chief of Engineers may then request appropriations for construction and post authorizations studies.
13. The Appropriations Committees of the House of Representatives and the Senate conduct public hearings each year at which local officials may present requests for the appropriations to carry out authorized projects.
14. When approved by the committees, construction funds for specific projects are included in the annual Civil Works bill.

15. After the Civil Works bill has been approved by both Houses of the Congress and signed by the President, the Corps of Engineers proceeds with construction.

The Corps of Engineers performs investigations of major water and water-related resource projects only under specific authorizations by the Congress. Such authorizations are in the form of laws enacted by the Congress or resolutions by a House or Senate Public Works Committee. Section 1 of the Water Resources Development Act of 1974 (Public Law 93-251) established the two-phase authorization procedure for major projects.

Smaller studies may be performed by the Corps under its general continuing authority, which permits the Secretary of the Army and the Chief of Engineers to undertake investigations and construction of projects having a federal cost no greater than $2 million. For small flood control projects in areas that have been designated disaster areas within the past five years, the general continuing authority sets a $3 million limit. Other public works that may be performed under the Corps' continuing authority include projects not exceeding $250,000 for clearing and snagging or for emergency bank protection.

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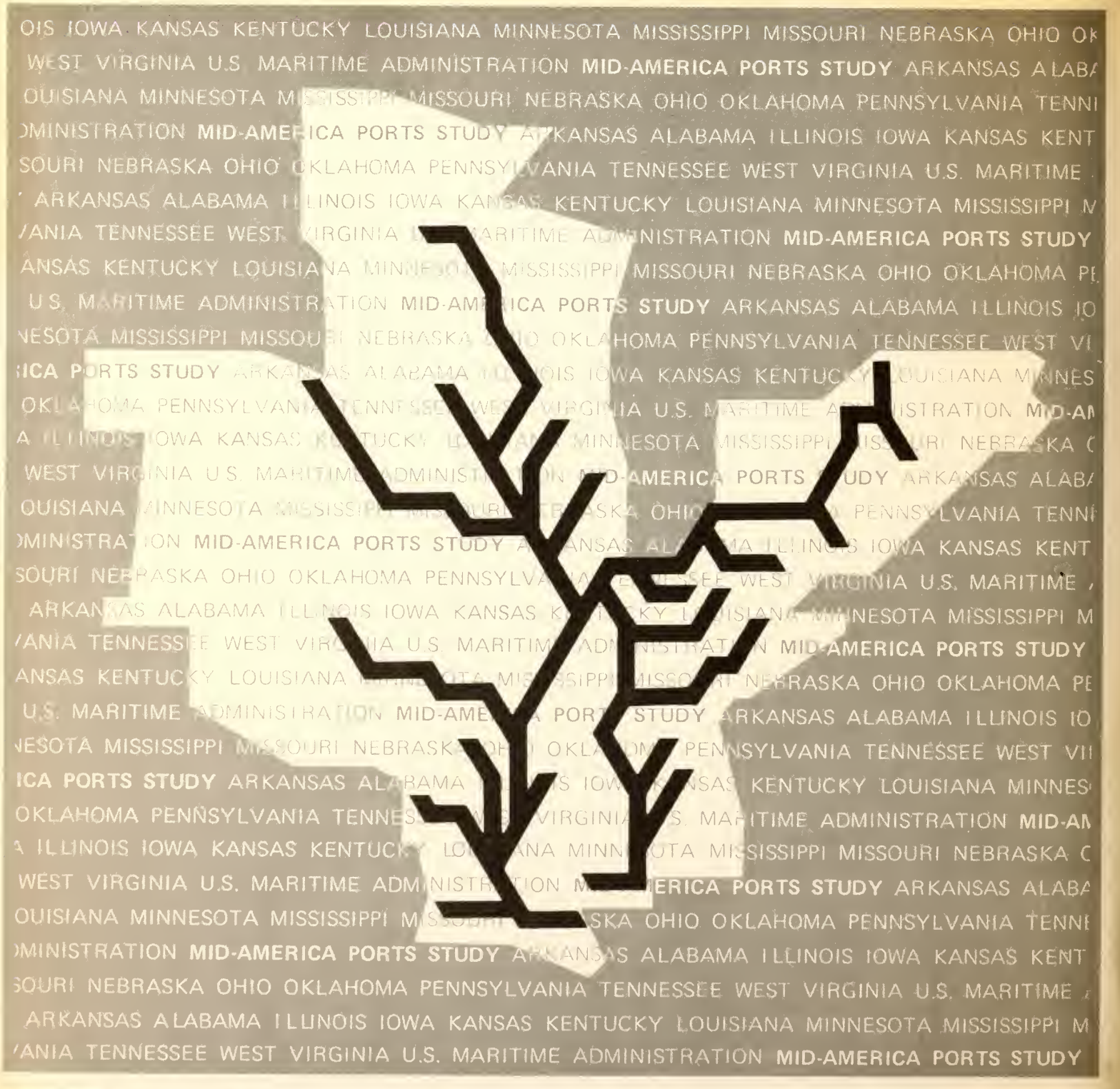
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